Communications Technology for Urban Improvement

Report to the
Department of Housing and Urban Development
under Contract No. H-1221

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...MMITTEE ON TELECOMMUNICATIONS
...IONAL ACADEMY OF ENGINEERING

COMMUNICATIONS TECHNOLOGY

FOR

URBAN IMPROVEMENT

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Committee on Telecommunications

National Academy of Engineering

Washington, D.C.

For further information contact:
Committee on Telecommunications
National Academy of Engineering
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

(202) 961-1414

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PREFACE

On February 1, 1970 a consortium of Federal departments at the initiative of the Department of Housing and Urban Development, and including the Departments of Transportation, Commerce and Justice, and the Federal Communications Commission requested this Committee to study (1) the possibilities for the better application of telecommunications technology to current city functions in order to improve city living and (2) the potential of such applications for stimulating favorable patterns of regional development.

In order to carry out a concentrated study of telecommunications for city problem alleviation, the Committee formed a Panel on Urban Communications chaired by Dr. Peter Goldmark. This Panel in turn was sub-divided into Subpanels along the following city functional and other specialized lines; Administration and Emergency Services; Communications Systems for the City - Present and Future; Crime Prevention; Education, Training, Recreation and Culture; Environment and Health; Transportation; Urban Attitudes to Panel Program; and The Cities of the Future. All of these Subpanels have tapped a wealth of external talent in their fields of inquiry. The fruits of their labor are nineteen potential city pilot project suggestions with a significant telecommunications content for the Committee's federal sponsors. Summaries of these pilot project ideas are contained in Chapters III and IV beginning on page 36 and page 164.

The work of the Committee has been so diverse that it has not been possible for the entire Committee to analyze the proposals of all the subpanels and to seek a consensus. Therefore, it was agreed that the recommendations made in this report are those of the individual subpanels or task forces as identified in each project description in Chapters III and IV.

The sponsoring departments established an Interagency Committee on Telecommunications (see page xiii) to work closely with this Committee's urban study and for other purposes of common concern. Subsequently the U. S. Postal Service joined the Interagency Committee in support of the urban study effort. Other Federal agencies which have been monitoring this activity through observers on the Interagency Committee have included the White House Office of Science and Technology, Office of Telecommunications Policy, Department of Health, Education and Welfare, Office of Economic Opportunity, and National Aeronautics and Space Administration.

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For the purposes of this study, telecommunications was defined very broadly. The definition proposed by the Committee, accepted by the sponsors and incorporated in the contract was:

"Telecommunications is any transmission, emission, or reception of signs, signals, written images and sounds or intelligence of any nature by wire, radio, visual, or other electromagnetic systems including any intervening processing and storage."

Note that this definition includes the use of computers, sensors, and transducers for any use in signal processing; transmission of information to a distant point is not required.

It is recognized that many forms of technology serve city needs and, at the same time, other forms may contribute, perhaps inadvertantly, to city problems. One approach to a study of "Technology for Urban Improvement" might be to consider all the many problems of the city and then determine what branches of technology are needed to attack each of these problems. An example of such a broadly based problem would be the field of transportation which could advantageously be studied by a team consisting of individuals drawn from many engineering and social disciplines. Such broad studies, needing interaction among, and education of, such a multidisciplinary team, require a minimum of several years to organize and carry out. Before such long term studies reach the report stage, conditions usually change. Time is of the essence and, under the best of circumstances, recommendations are difficult to bring to implementation. We believe that early results might be forthcoming if the policy suggested in the preface of our August 1969 report, TELECOMMUNICATIONS FOR ENHANCED METROPOLITAN FUNCTION AND FORM were carried out. This statement was:

"It is the belief of the Committee on Telecommunications of the National Academy of Engineering that various groups of engineers with special competence in a particular field of importance to city functioning should apply their expertise to an analysis of city problems that relate to their discipline. This should involve analyses of the problems and the proposal of plans for experimental programs that will contribute to advancing the welfare of the modern city and its citizens. Subsequently, the efforts of the several groups in such areas as communications, transportation, sanitation, construction, and so forth, may well be combined in the study of the city as an example of a complex organization to which the principles of modern systems engineering might apply."

The support by the government agencies of the study which resulted in this report was based on the approach, quoted in the preceding paragraph, of using a committee of specialists on communications who are knowledgeable in their field, conversant with city problems, and willing to go to the cities for further information. We did not wait for, nor could we make for ourselves, broader, more time consuming, and more expensive analyses which some critics have urged as desirable of the wide spectrum of city needs and problems.

In order to gain first hand knowledge of city problems the Committee requested a number of cities to list their needs in areas where telecommunications technology might be of some help. The Committee made a variety of cooperative arrangements for an exchange of ideas with the following cities: Washington, D.C.; New York City, N. Y.; Nashville, Tennessee; Chicago, Illinois; Peoria, Illinois; Atlanta, Georgia, and Sunnyvale, California. In New York City the Committee, with the close cooperation of the Police Department, focused its attention on the study of communications-electronics technology for crime prevention. In Chicago the Committee worked in close cooperation with the late Mr. George De Ment, Chairman, Chicago Transit Authority, on the application of telecommunications toward improving a city's transportation system.

These cities, and many others contacted by the Committee, have shown great enthusiasm for the goals of the Committee's study and have given their active cooperation. The contacts with the cities have repeatedly demonstrated their value to the Committee in affording it an early insight into the cities' real needs, subsequently providing a means of testing Committee ideas for technology applications with experienced city officials.

City reactions to the pilot project suggestions have been uniformly enthusiastic. The city representatives have noted that they are being given an opportunity to imagine and plan constructively for the future as opposed to "backing into it". They point to their inexperience in technology and welcome technological help. They also urge that an understanding be developed among the using public and among government officials of what the pilot projects represent. Some of the more complex projects may require new innovative organizational approaches to bring them to fruition. Most of them would require initial federal financial support because of the cities' stringent financial situation. Various cities reveal differing priorities for projects depending on their local needs. A summary of available city reaction is located in Appendix C page 211.

The Committee desires to assist in any feasible way the implementation of these concepts into ongoing pilot projects.

We realize that the cities' problems are great, the social pressure is mounting and the time is short; sustained positive action is needed.

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COMMITTEE ON TELECOMMUNICATIONS

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International Telephone and Telegraph Corporation

Richard P. Gifford
Vice President and General Manager, Communications Systems Division
General Electric Company

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IBM Fellow
International Business Machines Corporation

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Executive Vice President and Assistant General Manager
Hughes Aircraft Company

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Head, Department of Electrical Engineering
Massachusetts Institute of Technology

Ernst Weber
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PANEL ON URBAN COMMUNICATIONS - SUBPANEL MEMBERSHIP

Peter C. Goldmark, Chairman

Administration and Emergency Services

Daniel E. Noble*
George R. Rodericks, Director, Office of Civil Defense, District of Columbia

Cities of the Future

Peter C. Goldmark*
Harold P. Belcher (adviser), U.S. Postal Service
John Clinton (adviser), Department of Housing and Urban Development
Emerson Markham (adviser), U.S. Postal Service
John E. Mock (adviser), Chairman, National Governors' Council on Science and Technology
Philip Weinberg (consultant), Bradley University

Communications Systems for the City: Present and Future

Kenneth G. McKay*
Robert Adler*
Henri G. Busignies*
Allen E. Puckett*
Lynn Ellis (adviser), International Telephone and Telegraph Corporation
Hubert J. Schlafly (adviser), Senior Vice President, Teleprompter Corporation

Crime Prevention

Peter C. Goldmark*
Robert J. Potter*
William J. Kanz (adviser), New York City Police Department

Education, Training, Recreation and Culture

Edward C. Jordan*
Joseph M. Pettit*
Donald A. Dunn (consultant), Stanford University
William Sharp (adviser), Office of Economic Opportunity
Philip Weinberg (consultant), Bradley University

*Committee Members

Environment and Health

Robert A. Henle*
William H. Pickering*
Louis D. Smullin*
Roger Mark, M.D. (consultant), Massachusetts Institute of Technology

Transportation

Richard P. Gifford*
Ernst Weber*
George L. DeMent (deceased, former Chairman of the Board, Chicago Transit Authority)
Hugh H. Davids (adviser), General Electric Company
Ralph Tracy (adviser), Chicago Transit Authority

Urban Attitudes to Panel Program

Mark E. Keane, Executive Director, International City Management Association
Gustav Heningburg, President, Newark Urban Coalition, Inc.
Porter Homer (adviser), International City Management Association

STAFF OF THE COMMITTEE

Roman V. Mrozinski, Executive Secretary

Harry D. Frankel

Stanley A. Garlick

Richard C. Hopkins

Thomas G. Newman, Jr.

John J. O'Neill

Nancy L. Guild

Cecelia I. Larsen

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The Committee gratefully acknowledges the support and encouragement it has received throughout the course of the urban communications study from the Interagency Committee on Telecommunications composed of representatives of the federal departments sponsoring this Committee's urban study. Membership includes Mr. Alan R. Siegel, chairman, Dr. Calvin Hiibner and Mr. George W. Wright, Housing and Urban Development; Mr. Richard L. Beam and Dr. Arthur Goldsmith, Transportation; Drs. Armig Kandoian, John M. Richardson, and Robert S. Powers, Commerce; Mr. Walter R. Key, Justice; Messrs. Raymond E. Spence and Robert L. Cutts, Federal Communications Commission; Mr. Harold P. Belcher, Postal Service; from the Executive Office of the President, Dr. Lawrence A. Goldmuntz, Office of Science and Technology, Mr. Walter Hinchman, Office of Telecommunications Policy, and Mr. William Sharp, Office of Economic Opportunity; Mr. Ronald J. Phillips, National Aeronautics and Space Administration; Dr. Albert L. Horley and Mr. Ray Stanley, Health, Education and Welfare. These individuals have made many constructive contributions to this Committee's urban study.

We express our great appreciation to the many city officials who have cooperated wholeheartedly in the Committee's urban study effort. These officials have given the Committee invaluable insights into the day-to-day problems with which the American city is confronted today; in addition, they have reacted to the Committee's project suggestions with candor. The Committee trusts that it can reciprocate this cooperation by supporting the implementation of the full range of communications pilot project suggestions for city improvement.

Other individuals who have been of great help to the Committee in analyzing the many complex problems and the potential for application of telecommunications in the city are Messrs. Raymond L. Bancroft, Ross Davis and Lawrence Williams, National League of Cities; Mr. Robert Havlick, International City Management Association; Mr. Kenneth M. Gregor and Dr. Frank X. Steggert, Atlanta Urban Observatory; Mr. Robert A. Horton, Metropolitan Nashville Urban Observatory; Messrs. Edward J. Roth and John P. Witherspoon, Corporation for Public Broadcasting; Messrs. Louis Blair and Harry Hatry, Urban Institute; Messrs. Paul L. Laskin and Konrad K. Kalba, Sloan Commission on Cable Communications; Mr. John P. Thompson, Arthur D. Little, Inc.; Dr. Robert Peters, Stanford Research Institute; Mr. Charles A. Zraket, The Mitre Corporation; Professor J. H. H. Merriman and Messrs. S. H. Granger and C. F. W. Hawkins, British Post Office; and Dr. John deMercado, Canadian Department of Communications.

The communications-electronics industry of the United States has cooperated fully with the Committee in outlining the current state of the art and the foreseeable trends in technology applications for city improvement.

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SUMMARY AND RECOMMENDATIONS

Our cities have many problems in urgent need of solutions. City governments have a requirement for closer communications with their citizens and readier response to citizen needs. City schools are less than satisfactory in providing quality education to the nation's youth. Medical care is inadequate for the cities' poorer and older citizens. Individualized transportation is clogging the streets and polluting the air. Public transportation is often inefficient and unattractive to its users. Law enforcement agencies have difficulty in coping with a growing crime rate.

The Committee believes that modern communications technology, thoughtfully applied, can help in relieving many of these problems and in upgrading the level of city life. This conviction has been further confirmed as a result of the Committee's in-depth study of city operations, and a continuing exchange of ideas with officials in a cross-section of U.S. cities. We would suggest that our efforts in telecommunications might well be followed by, and combined with, those of technologists in transportation, sanitation, energy, utilities, construction, and other fields, in the study of the city as a highly complex organization to which the principles of modern systems engineering can be applied. However, we believe that this initial effort to suggest remedial telecommunications applications to alleviate city problems should not be delayed while waiting for a broader look at the analysis of city requirements, as some have suggested. Time is too valuable an ingredient in the alleviation of city problems to be expended while we probe for a more systematic approach. An attack on city problems must be made now.

Evolutionary Communications Concepts

Present city communications systems -- telephone, radio (including mobile), television and broadband cable networks -- each has unique characteristics and functions to support important parts of the total city environment. Each of these systems has untapped potential for serving the cities' growing needs. These systems can serve as basic building blocks for an increased spectrum of both basic and innovative city services.

In the evolutionary development of practical and economically viable non-mobile city communications systems over the foreseeable future, we can visualize conceptually four types of basic networks:

1. The developing telephone network which can transmit pictures, voice, and written materials between two points.

2. A network based on existing cable television systems which can distribute information from central facilities to offices and homes. It could have a capacity equivalent to as many as 30 TV channels and a limited callback capacity for polling or making requests.

3. A third network could involve a broadband communications highway carrying up to 30 equivalent TV channels in both directions, interconnecting the major public institutions and large commercial enterprises of the city.

4. A multi-purpose city sensing network could collect data on such items as weather, pollution, traffic, vehicle location, and power status.

The various pilot projects suggested by the Committee would economically and efficiently make use of one or another of these evolutionary networks.

The full potential of the combined city communications networks can best be realized in the modeling of a regional development project as described in Chapter IV of this study, or in the new communities being developed throughout the country.

Pilot Project Suggestions

The Committee suggests the following pilot projects which have a significant telecommunications content:

Citizen-Government Interaction

Design and demonstrate a model Community Information Center, serviced with modern video, facsimile, and telephone systems, to provide improved city services to the citizen.

Education

Explore the effectiveness of various forms of two-way instructional television in improving the quality and distribution of educational services among the urban population.

Demonstrate the provision of community information

retrieval services to the school and home over cable television with limited subscriber response capacity and interactive terminals.

Demonstrate the effectiveness of advanced computer-assisted instruction in developing reading and mathematics skills at the grade school level and explore the potential for distribution of CAI services over cable television with limited subscriber feedback capacity.

Health

Examine the useful medical services which can be provided by a variety of available communications systems (radio, video, facsimile, or data transmission).

Establish and operate on a trial basis a telemedicine communications system between a central hospital and several satellite clinics.

Demonstrate methods for extending the ability of physicians to provide nursing home care through more effective utilization of modern communications and paramedical personnel.

Pollution

Develop and test the operation of rugged and reliable long path sensing devices for remote air pollution monitoring.

Transportation

Design and operate on a trial basis a fully automated transit user information system.

Develop and demonstrate an automobile - mass transit interchange station, including facilities for automated parking, electronic fare collection, pedestrian guidance, and instantaneous transit information.

Study the potential for reducing city travel through the availability of modern communications.

Crime Prevention and Emergency Services

Implement a 24-hour television surveillance system to help protect citizens from crime on city streets. Integrate several communications techniques into a security system for housing projects and public institutions.

Develop and test in one or more cities a system to automatically locate the origin of incoming emergency calls to a city's emergency operation center, in order to reduce response time and make it practical to implement a single emergency number such as 911.

Develop a model Municipal Command Center supplied with currently available electronic communications equipment to enable responsible city officials to plan effectively for, and respond to, city emergencies.

General

Establish and periodically update technological standards for cable TV franchises. Publish an authoritative broadband communications systems handbook, incorporating these standards. Advise, on request, public authorities who have franchising responsibilities.

Study the operational needs of potential city users (e.g., police, taxis, trucks, ambulances and other emergency vehicles) for an automatic vehicle monitoring system.

Conduct necessary research on urban radio propagation characteristics to establish a data bank useful to designers of city communications systems.

Special Recommendations

Support the increased participation of minority groups in the legal and other professional aspects of the communications field.

Encourage the development of projects in support of low-cost local programming of noncommercial cable and over-the-air television channels.

The Cities of the Future

The Committee has focused on the problems which have developed within our cities today and has sought the means to alleviate these problems. We maintain that many of the cities' problems are caused by high density living conditions in an era of increasingly rapid change. Communications technology, imaginatively applied, could offset the trend in which the vast majority of Americans today, and more in the future, live on a small percentage of the available land.

We suggest an exploratory program to examine how broadband communications technology could be applied to business,

government, education, health care, and entertainment to stimulate the development of existing small communities, or new communities, in rural areas. As a result, people would have a viable option of settling in either urban or rural America.

CHAPTER I

THE CITY: PROBLEMS AND OPPORTUNITIES

What is a city? For some, it is where the action is. For others, it's where the jobs are. For all, it is a tight, complex mass of humanity.

Under closer scrutiny, a city has its multitude of individuals somehow making the difficult decisions between a desire for identity and the absolute necessity to accommodate to the organization and discipline required for coexistence in close living conditions. The challenge in urban planning is no longer how to make cities larger, but rather how to make them more livable and efficient in performing the functions useful to their inhabitants.

Arnold Toynbee is not alone in observing that:

> The closed city converging on a center point is no longer a workable configuration even for a single city now that it has been mechanized and is consequently expanding.*

Whatever solution is developed, according to Toynbee, it must be one in which the social setting for the inhabitants is on "no larger a scale than that of a rural village." Idealistic thinking? Probably -- if we continue to look upon cities as simply the consequences of the past, plus technology.

But the time has come for man to set social goals first and then challenge technology to get him there. We have the opportunity based on technology to develop new objectives for a better life in both the urban and rural environments. We can challenge technology to "repair" some of the consequences of the urbanization trend that accelerated in the industrial revolution. We can work to improve life in cities that already exist and we can plan ahead to avoid the existing city problems in our cities of the future.

In examining the challenge of existing cities we are inclined to start with a conceptual view similar to that of

*Toynbee, Arnold, *Cities on the Move*, Oxford University Press, 1970.

Lewis Mumford*, who describes the modern city as primarily a machine for storing and processing information. One could dispute the simplicity of this view as it ignores the physical aspects of trading - at least as we now know them. But the thrust of his observation certainly merits consideration in relation to the challenge of the cities, and will be developed further in this report.

As a first step in seeking effective application of telecommunications technology to our urban environment, we have sought a better definition of urban problems and needs. Many cities have been examined partially and a few in detail. An immediate observation is that many cities function under similar conditions. Their shortcomings and strengths often display a common thread. However, their problems have not been brought into sharp focus. The urban environment is too complex, unbounded and dynamic for that. No simple understanding of urban dynamics is likely to be accurate and no quick technological panacea is likely to be effective.

With this understanding that city problems are interrelated, and that sincere men may disagree on what are symptoms and what are root causes, we suggest that some helpful solutions may be available through thoughtful modeling and experimentation. We have attempted to categorize and diagnose problems and opportunities in our cities, together with technology-based possibilities for improving city life. In the following paragraphs, areas of critical importance to the city are discussed. We believe that the suggestions for urban communications improvements can be steps toward a more livable city environment. At the same time we recognize that time limitations will prevent an exhaustive examination of all the possibilities for the application of telecommunications technology to city problems.

Citizen-Government Interaction

Municipal government is mainly involved in the delivery of basic services to its citizens. However, there are surprisingly few effective channels of communication between the local officials and the community at large. Readily obtainable citizen reaction to city government is an important requirement for quality service, and yet opinion surveys are usually difficult and costly, if not totally impossible. The one-way characteristic of the newspaper and broadcast media

*Mumford, Lewis, *The City in History*, Harcourt, Brace and World, 1961.

allow only for minimal citizen participation in decision making.

From the citizen's point of view channels for any communication with city government often involve barriers of frustration. For service requests, information, or emergency aid the citizen is often faced with delayed and/or inadequate response, or, too often with what he considers no response at all.

There is great need for techniques of closing the gap between the local government and the community for the purposes of stimulating citizen participation and effectively bringing municipal services to the public.

Education

For some the city means educational opportunity. In or near large cities are many of our prestigious colleges and universities, our experts, writers, and artists, our publishers and editors, our museums, libraries, galleries and theaters. Those who want to learn or teach most often come to the city to exchange ideas and to gather and disseminate information.

In contrast, the common public schools in the central city have become increasingly less capable of fulfilling their mission as evidenced by existing statistics on serious absenteeism and other problems. Illustration: in New York City, 50% are absent from class every day, and 25% drop out before completion of the 12th grade. The shortcomings of the urban educational process have been well documented both by newspapers and educators. To compound the problem, educational costs are rising at a rate such that administrators cannot finance building costs and teacher salaries, not to mention experimentation with new approaches which differ from conventional classroom instruction.

The goals of any program for improved urban education should include increasing the attractiveness, relevance, and availability of service to the educationally deprived, and making education more available to all people. Vast opportunities for communications technology in upgrading the nation's educational opportunities lie with the computer, two-way cable television, and, perhaps more importantly, the willingness and capacity of teachers to make them work.

Health

The major problems in providing adequate and quality medical care -- whether to urban or rural areas -- are (1) the limited number of practicing doctors, (2) their uneven geographical distribution, and (3) the suboptimal utilization of available physicians' time.

The scarcity of physicians is most obvious in rural areas where it is not unusual to find moderate sized communities which cannot attract even a single doctor. The uneven distribution of physicians is most apparent in those urban areas where large segments of the population, particularly those in poor sections, are served by a few overworked practitioners, while nearby extensive medical centers attract large numbers of physicians.

It is widely accepted that in order to improve the quality and availability of medical care for all citizens, new distribution strategies must evolve. Such systems of medical care should significantly extend the services of individual physicians, both geographically and in terms of the number of patients each can adequately serve. It is also generally agreed that one key to success in such systems lies in the more effective use of physician assistants and other paramedical workers. Technology, particularly telecommunications and data processing innovatively applied, can play an important role in providing improved medical care throughout the country.

Pollution

The effects on environmental pollution are of ever increasing concern to our citizens, particularly those who live in metropolitan areas. Individualized transportation using the internal combustion engine is the number one offender. Recent national, state and local legislation has taken some initial steps toward the control of pollution, but their effectiveness depends to a large extent on the development of systems which can detect and collect information on the presence and amount of dangerous pollutants. The development of these systems is not constrained by currently available techniques of data transfer and processing. Rather, the problems are how to determine the presence of pollutants, the qualitative and quantitative pollutant information needs of the system users, and finally, the development of rugged, reliable, low cost pollution sensing devices. Work is ongoing to solve these problems, but much more is needed, particularly in the development of efficient sensors.

Transportation

Transportation of people, goods and services is manifestly complex when quantified as to high volume, density, queuing, transfer and diversity of end points. The cities of the Nation, now faced with the urgent need to establish priorities between essential systems and those merely convenient, need to determine techniques which favor non-congestive services.

Opportunities for improved transportation exist partially in upgrading traffic control. However, it is the greater use of mass transit which will do most to alleviate the problem. The existing applications of telecommunications to the operation of rapid transit, bus routes, and highway traffic have provided improvement, but there have been an inadequate number of innovations. Block signals, switch towers, and wayside telephones aid rapid transit systems; point supervisors, terminal telephones, and pressure from the riding public, maintain a degree of service regularity on bus routes; pavement markings, signs, and signal lights control the flow of 105 million motor vehicles. New applications of available communications/electronics technology are needed to improve mass transit systems (and so make them more attractive), reduce travel times, and alleviate the loss of life and property caused by automobile accidents. Improvements could be made with better citizen access to transit information, improved transit scheduling techniques, and the development of efficient and attractive transportation transfer facilities where those who start their trips in automobiles can easily park and transfer to mass transit systems.

Crime Prevention and Emergency Services

Local officials responsible for serving the community under emergency conditions are at the focal point of urban problems. Crime, civil disorder, and a whole range of crisis situations, place extraordinary requirements on city government. Crime and the fear of crime has been a major factor in the steady exodus of business, industry, and the more affluent families from the central city to the suburbs. The control of crime and alleviation of fear of potential crime have become major tasks for public safety officials.

Law enforcement officials point to the need for specially designed tools to fight particular crime problems. The control of street, public housing, and school crimes and acts of violence might benefit from systems including

low light level television surveillance and personal alarm devices permitting an individual to notify authorities quickly and directly in cases of need.

Often municipal governments have approached the problem of emergency services in the form of individual operations. Thus the police, ambulance service, fire departments, sheriffs, emergency road services, and hospitals operate autonomously and are not well coordinated with one another. There exists an opportunity for increasing effectiveness and efficiency and cutting costs through integrated emergency response systems. Such concepts as emergency operating centers utilizing a single short and readily remembered telephone call number (e.g., 911) with an automatic location identification feature, hold significant potential.

Random telecommunications have thus far been invaluable to man in storing and processing the information of the modern city. For the future, a well-integrated system of city telecommunications, designed to alleviate the roadblocks to information exchange under both emergency and normal operating conditions, is required for urban improvement. When these communications improvements are made on a planned and systematic basis, they can be cost effective in terms of the benefits gained.

CHAPTER II

THE ROLE OF COMMUNICATIONS

Current Status of City Communication Systems

There are many telecommunications systems operating in every urban area. These systems range from the ubiquitous telephone to the newer cable systems, and from the pervasive radio and television networks to the mobile radio. Each has unique characteristics and functions that serve to support critical parts of the total urban environment. None has fully tapped its potential in serving the citizen. This report addresses both the unique characteristics and the potential of the telecommunications systems.

To establish a reference point this chapter reviews some of the major telecommunication systems in existence in almost every urban area. The remainder of the report employs these concepts as basic building blocks and goes on to suggest modifications and hybrids in an attempt to provide a full spectrum of both basic and innovative uses.

Telephone

The major vehicle for personal communication is the telephone. The telegram has a steadily declining role in personal communication, with many of its former services now being taken over by telephone, Telex, and TWX. Telephone conversations are now a major substitute for first class mail. The thirty largest urban centers of the United States contain over 37 million telephones, one-third of all the telephones in the country. Approximately 65% of these are for residential use, the rest are for business, government and others. The usage is high -- the five million telephones connected to the common carrier network in New York City alone generate more than thirty million calls each business day. The accessibility is high -- over 90% of all residences in the country contain at least one telephone.

What are the essential limitations of the telephone network? Since it is still evolving, current limitations do not necessarily measure its future applicability. However, certain fundamental considerations should prevail. The telephone network is engineered to optimize selective, two-way, private user-to-user communications. Hence it is less suitable to the broadcast mode: radio, TV broadcasting, or CATV. Similarly, simultaneous data gathering at one point from many locations,

e.g. voting, although not impossible, does appear costly using a telephone network. It is a tightly coupled network and it is capital intensive; the undepreciated telephone plant in the country totals $60 billion. We can conclude that on a nationwide scale any fundamental change will occur on an evolutionary rather than a revolutionary basis.

Video-Phone

This evolutionary trend is illustrated by the current status of the video-phone. It was designed for face-to-face communications, although it can also provide a visual display from a computer. Since July 1970, it has been offered as a tariffed item in downtown Pittsburgh and will be offered in several other cities in 1971. Its growth is expected to be gradual, although the impact of alternative use of the facilities for high speed data communication is yet to be determined. However, at a monthly cost to the user for video-phone service that is comparable to the yearly cost for telephone, it is felt that the overall impact of video-phone on urban communications would probably be small for some years to come. As the cost picture changes, so may this conclusion.

Telephone Data Networks

The business community has pioneered the use of the telephone network, including leased lines, for the transmission of all forms of data. It is most likely to continue to do so through the foreseeable future without requiring any external incentives. Heavy users of data communication will undoubtedly rely on dedicated end-to-end digital transmission systems. However, it seems evident that many public services such as health, law enforcement, and city administration have not yet organized to take full advantage of what is currently available. Consequently the Subpanel* has placed considerable emphasis on the desirability of urban public services organizing to optimize the use of available modes of communication. The flexibility is high -- virtually all data that is electrically communicated flows over the common user network or over leased lines that are physically integrated with the network. Here the variations seem inexhaustible: they range through keyboard to keyboard operation, card to tape, tape to tape, low or high speed facsimile, electrocardiogram transmission, human to computer via keyboards or Digital-Inquiry-Voice (or Video) Answerback. The users' problem is frequently that of organizing to make the most economical and effective use of available facilities and of devising economical terminal equipment.

*Subpanel on Communications Systems for the City: Present and Future

Mobile Radio

The major allocation of channels for use by designated categories of mobile, portable, and paging radio communications services, was established by the FCC after extended hearings held in cooperation with the industry-oriented Radio Technical Planning Board. For the mobile and portable radio communications services, blocks of channels were assigned in the four bands, 30 MHz, 150 MHz, 450 MHz and more recently the 900 MHz region. Specific radio service categories include the public safety, land transportation, and industrial and domestic public land mobile. Since the formal allocation of the channels there has been a substantial steady proliferation of mobile radio telephone systems operating in all categories. Primarily, these two-way voice communications systems use push-to-talk, and release-to-listen operation to make unnecessary the elaborate filtering and frequency separation between mobile and base station carriers ordinarily required for duplex operation. An exception is the improvement brought about by use of full duplex, automatic channel selection and dial operation by the common carriers. Over the past 25 years of operation and growth of the mobile radio systems there has been important steady progress in the introduction of design refinements to control the transmission and reception of spurious signals, and to reduce the susceptibility of the systems to adjacent channel interference and interference by intermodulation and saturation effects. Perhaps the major change over the past few years has been the increasing use of solid state components and integrated circuits in both the base station and the mobile equipments, and the investigation of the potential of the newly assigned 900 MHz region. Appendix B deals with additional mobile radio technical considerations.

Radio and Television Broadcasting

The Commercial Service

Practically our entire population has "instant" exposure to the news of the day and the trends of tomorrow. There are more radios than people in this country and 95 percent of our 60 million homes have their television sets tuned in on an average of five hours and 45 minutes a day.

Broadcasting facilities increase each year. As of March 25, 1971, there were operating in the United States 4,328 commercial AM radio stations and 2,205 commercial FM stations. Construction permits were outstanding for 87 AM and 271 FM stations. Applications for new AM stations totalled 225, with 331 for FM stations.

On March 25, there were 503 VHF and 181 UHF television stations, with 11 VHF and 99 UHF permittees not yet on the air and 62 (37 VHF, 25 UHF) applications pending for new commercial stations.

The vast television viewing audience continues to grow substantially each year for all segments of the day's programming. Findings by Statistical Research, Inc., published in Broadcasting Magazine on February 1, 1971, showed that in November 1970 sets were on in 36,893,000 homes (60% of all television homes) during Monday through Sunday prime time, with 55,070,000 adult viewers. Adults are 18 years old or over for these statistical purposes.

Monday through Friday late news turned on 24,419,000 sets, with 36,812,000 adult viewers. All other segments of the day's scheduling showed substantial millions of sets turned on and millions of adults viewing the programming.

There are other broadcast services which are often overlooked, such as FM subcarrier transmission of background music and announcements in stores and offices. There are also stock quotation services, facsimile transmission and numerous teletype applications.

Additional services have been proposed for public safety. These include transmission of tornado alerts, traffic warning and rerouting information to drivers, etc. They may employ standard broadcast channels.

Currently, the National Bureau of Standards is considering another use of television broadcasting called the "vertical-interval period" to transmit exact time signals and standard frequency tones in piggyback fashion. The vertical-interval period is that time span between the end of one television picture frame and the beginning of the next.

Other uses of the vertical-interval period for data transmission are being studied to provide extra use of the broadcast spectrum without interfering with existing services. These include communications links to affiliated network stations, the transfer of daily program logs, and news wire distribution.

Among recent experiments conducted where newspapers and other information services were delivered over the broadcast spectrum was one authorized by the FCC in March 1971 which involved the transmission of an entire newspaper page using an FM subsidiary carrier.

Since 1965, United States commercial satellites have been relaying television and radio broadcasts together with telephone calls, telegraph messages, facsimile and computer data across the Atlantic, Pacific, and Indian Oceans. It is interesting that a single satellite can handle almost as many circuits as are now available for telephone and telegraph transmissions from the United States to the rest of the world by undersea cable and high-frequency radio. For example, Intelsat IV, launched this year, provides 6,000 telephone circuits, the equivalent of 6 television channels.

Satellites will greatly enlarge the ability of the networks to serve their affiliated stations, particularly with news and public affairs broadcasts and special events. Additionally, satellites will greatly augment the usefulness of networks in national emergencies and for civil defense.

Countries other than the United States are making plans to use satellites for broadcasting purposes. By 1972, Canada expects to have a satellite system in operation which will beam television and other communication services. A satellite operating 22,300 miles above the Indian Ocean will beam educational television programs to relatively inexpensive receiving stations in 5,000 villages in India by 1975, at least a beginning for India's 560,000 villages. Japan, Australia, Brazil, and Pakistan are also planning satellites. In Europe, several organizations are studying the possibility of regional European satellite systems for broadcasting purposes. Clearly, the use of satellites for commercial broadcasting purposes opens up interesting possibilities, although their impact may be greatest in countries where existing communications networks are less highly developed than in the United States.

Public Broadcasting

Few realize that it is over 51 years since educational radio was first broadcast out of WHA, Madison, Wisconsin and 36 years ago, Professor H. L. Eubank of Wisconsin testified before Congress on the matter of reserving AM channels for educational broadcasting. At the time, Professor Eubank was speaking for a group of Mid-Western State Universities which was later to become the nucleus of what is now The National Association of Educational Broadcasters. Today, there are 457 public radio stations in the United States: 25 AM and 432 FM. No accurate audience figures are available for the educational/public radio system. It is estimated the signals of the 457 stations reach 75% of the population.

The first modern educational television station, KUHT, began operating in Houston, Texas in 1953. Since that time the growth of educational or public television has been constant, with 194 stations (85 VHF and 109 UHF) on the air by the end of 1970. An educational/public television station is located in every state except Alaska, Montana, and Wyoming, and the total group of television stations now serves 74% of the American people. Research indicates some 33 million people view public television each week.*

The record of the development of educational broadcasting, now generally known as public broadcasting, is impressive. Educational/public broadcasting entered a period of growth in 1967 when the Congress established the Corporation for Public Broadcasting and handed that organization a mandate to create a renaissance in public communications.** The assignment was not an easy one.

Specifically, the Corporation for Public Broadcasting was assigned by Congress the tasks of:

a) Facilitating the full development of educational broadcasting in which programs of high quality are made available to noncommercial educational television and radio broadcast stations;

b) Assisting in the establishment and the development of one or more systems of interconnection to be used for the distribution of educational television or radio programs;

c) Assisting in the establishment and development of one or more systems of noncommercial educational television or radio broadcast stations throughout the United States; and

d) Carrying out its purposes and functions and engaging in its activities in ways that will most effectively assure the maximum freedom of the noncommercial educational television or radio broadcast systems and local stations from interference with or control of program content or other activities.

*Source: Louis Harris and Associates.

**Public Law 90-129, 90th Congress, S.1160, November 7, 1967.

Today, the stations of public broadcasting are linked together nationally by two organizations:

1) The Public Broadcasting Service (Television)

2) National Public Radio (Radio)

The main responsibility of these organizations is to distribute programs which have been produced by stations and by other sources to television and radio stations in the developing national PBS and NPR Networks.

The 194 public television stations are licensed and operated by various entities:

a)	State or municipal authorities	43
b)	School systems	22
c)	State boards of education	17
d)	Nonprofit community corporations	53
e)	Universities	59

The 457 public radio stations are licensed to the same types of organizations as public television stations, but a high percentage broadcast limited schedules on limited power. To insure the effectiveness of its assistance, the CPB established qualifying standards for public radio stations. At the present time, ninety-two stations qualify under these standards as stations providing full service. These stations are located in 32 states, the District of Columbia, and Puerto Rico.

The most critical problem facing public television and radio today is funding and budget appropriations. The Carnegie Corporation in its 1967 report "A Program for Action" identified the need for an institution to guide public broadcasting free of political interference. The report also suggested $270 million would be required annually to provide the country with a sound noncommercial broadcasting service. Of this $270 million, $104 million would be funded by the then proposed Corporation for Public Broadcasting and the remainder by states, cities, and private sources.

The resolution of the financial problem is probably the single most important task for public broadcasting today. It is evident that the CPB requires substantial funds to fulfill its obligations to the public. Until a permanent system is

established to finance public broadcasting the full benefits of long range planning will not be realized. The prognosis for the near future is an optimistic one. Construction of the two new national networks is progressing at a rapid pace. Programs are being produced and successes have already been achieved. When long range funding becomes a reality, the Corporation for Public Broadcasting will have all the tools necessary to create a national broadcasting service.

Broadband Cable Networks

Within the past 20 years, a new communications medium has developed in the United States that will have a far-reaching impact on the social and economic structure of our society. It has been called by several names, starting out as Community Antenna Television (CATV), then Cable Television, and today some persons are beginning to use the words Broadband Communications Networks (BCN). Each name relates to a stage in the development of the industry: Beginning - Present - Future.

A. CATV - Community Antenna Television - Beginning

CATV had its beginnings 22 years ago (1949) when there were very few television stations. Several television repairmen, who also sold sets, determined that if they could bring television signals into their localities or supply better signals, they could sell more sets, have more service business, and incidentally make a profit selling the imported or improved signals. The few TV station signals available at that time were limited by distance and/or physical obstacles, such as hills, from reaching many communities in the United States.

These early CATV system operators, by building a high tower on a hill and using directional antennas with amplifiers, and then running cable with additional amplifiers from the tower to the community, distributed the television signal in much the same manner that telephone service is distributed to the home. There is one important difference. The telephone service is a switched service on a person-to-person basis. The CATV signals, on the other hand, are a one-way type of service, available to all persons connected to the CATV cable. This important distinction had no particular significance at that time; however, as CATV systems developed, it began to take on considerable importance. By 1952, 3 years later, the number of operating systems had increased to 70 serving 14,000 subscribers, and the business was attracting the small business entrepreneur.

CATV, during the early years of its development, was primarily a so-called "Mom and Pop" operation, characterized by local ownership and operation of individual systems, most of which were located in smaller communities. These systems had a capacity of one to five television signals. The equipment for these early systems was primitive -- many systems being constructed with home-built electronics. By 1961, the number of systems had grown to 700, and the number of connected subscribers to 750,000. From 1951, this represented an annual growth rate of 29 percent for systems and 55 percent for subscribers.

The Federal Communications Commission originally considered CATV to be a local phenomenon, and thus not a part of interstate commerce. In April 1959, the FCC stated that it lacked regulatory authority over CATV. Local communities, on the other hand, from the very beginning, exercised their franchising authority over CATV systems and, in most cases, exacted fees -- usually a percentage of the gross revenues -- for the CATV systems' use of the public right of way. The reason for the beginnings of CATV and its early growth was simply the demand of the public for television signals in isolated areas. CATV served this need by bringing in television signals which were not available in any other way at that time.

The broadcasting industry originally supported CATV, seeing it as a way to extend broadcast coverage. Telephone companies were involved with CATV from its inception because the cables used in distributing the signals were attached to their poles. Some set up CATV systems inside and outside of their operating territories, and others, including the Bell System, participated in the construction and subsequent lease-back of systems to system operators. Appendix A provides a chronological listing of major changes in cable television from the early 1960's to the present.

B. Broadband Communications Networks (BCN) - Future

The growth of cable communications has resulted from the demands of the public -- first just for the signals which they could not receive, and later for the improved service and increasing diversity of service that CATV offers. Because of this demand, entrepreneurial business interests have been attracted to the industry by its large growth potential and the opportunity for high profits and long term capital gains.

As the industry goes into the 70's, a basic characteristic of CATV versus telephone service becomes apparent and also shows that the two do not really compete. Telephone service into the home essentially has a frequency bandwidth of 3500

cycles per second (narrow band) and is a switched system for connecting any two subscribers together. CATV service has a frequency bandwidth of 300 million cycles per second (broad band) with the possibility for limited return communications. However, the limited return communication, in the absence of a complex switching system, is generally to a single collection point, or "head-end," serving perhaps several thousand customers. It is characteristic of this system that all subscribers have available at all times the broad band of communications so that signal selection is accomplished with a switch in the TV receiver.

Through technical developments in the last two years, it is now practical and economically sound to furnish 20 or more television channels to each connection. This capacity is already built into most systems constructed since 1970.

With the limited two-way feature added to a CATV system, and by use of a centrally located digital computer, the following services could be demonstrable within the next twelve months. (How fast these services will be added to the CATV systems now in operation and under construction depends on the demands of the marketplace and the ability of manufacturers to produce economically the components in sufficient quantities.)

1) Give the subscriber the right to select any one of twelve or more free television channels as the demand develops, including local TV broadcast stations, distant TV broadcast signals such as are permitted by the FCC and copyright regulations, locally originated nonbroadcast programming, and possibly nationally distributed cable programming via domestic satellite systems. Sufficient bandwidth exists to provide for cultural, educational, ethnically oriented, and religious channels, as well as entertainment.

2) Provide restricted channels that would be available only to an authorized group such as doctors, lawyers, public administrators, etc.

3) Provide the means to order merchandise or services from product demonstrations or offerings on available television channels, or by suitable product identification supplied from other sources such as catalogues, direct mail, or advertising media.

4) Permit viewer participation in public preference polling, with optional means for protecting the identity of the responder.

5) Provide warning of fire, medical, or intrusion emergencies in the home. This information could be screened, or forwarded directly to the municipal emergency service authorities.

6) Provide educational channels with a student response capacity.

7) Provide statistical data relating to television viewing preferences.

8) Provide turn-on service in the home for lights, heat, warning systems, or other auxiliary terminal equipment.

9) Provide readings of the various meters used for electricity, gas, and water, send the reading directly into the public utility computer, and return the computed monthly billing to the user.

10) Provide facsimile page-type or strip-type hardcopy or electronic readouts in the subscriber's home for messages or statements.

11) Provide means for capturing and storing for continuous display single pictures from a shared television channel (the frame grabber) as an efficient and convenient means of delivering "still" picture or slide information to the home.

12) Provide channels on a lease or free basis for use in programming by independent persons or agencies. Legal problems relating to carrier liability will have to be solved prior to extensive use of this service.

13) Provide access to premium programming with color and resolution capacities superior to broadcast standards, using specialized home terminal viewing equipment.

There are many other functions which this new service will be able to perform. The feasiblity of the technology has been demonstrated, and, considering the present state of development and activity in this field, it is expected that hardware will be available in quantity within two years. Appendix A deals with the technology of present cable television systems and their potential evolution into Broadband Communications Networks (BCN's).

By 1972, most systems under construction will have a capacity of 20 or more channels, and will have limited two-way

service. Implementation of that service should be well under way by 1973, and by 1973 all the services discussed above are expected to be available if the market requires them. This is, of course, a big "if." Limited two-way cable transmission service, including terminal and head-end modifications, will require an incremental capital investment by the cable operator of 50% to 100% more than his present one-way service. This investment is expected to be recovered by retaining, or possibly decreasing, the basic charge now established for present services, and by making additional charges to the subscribers who use optional services.

From a sociological viewpoint, the cable television system with limited two-way capacity will have significant impact. The system provides the means for large-scale educational projects to all segments of the population. It also provides for programs allowing local groups to express themselves to their own area, to the region, or the nation at large. This service offers great promise for better understanding and communication among and between the diverse opinions extant in our society. Careful regulation will be required to assure that access to this new broadband communications network is available to all segments of our society.

At this point it is important to note a rather different concept for the development of broadband cable systems. Conventional CATV has evolved as a tree-type network in which all signals are delivered to all subscribers, with channel selection accomplished by a switch in the subscriber's television set. Another approach to cable distribution would use a hub-type switched network. Each subscriber would require an individual conducting path from a central switching point to his home. (Recent developments include low-cost unshielded multipair cables which provide transmission up to 15 MHz and switching equipment to go with them.) Subscribers receive only one video channel at any given time and can select this channel by means of built-in return communications to the switching center. An important feature of this concept is its inherent two-way capacity. With most of these systems, signals can originate at any subscriber location and be routed within the network without the constraints of sharing upstream channels. An important limitation of this concept is that each terminal (TV set) requires a separate cable from the switching center. Therefore, if a second TV set is to be used in a subscriber's home, a second cable path would be necessary.

<u>Interactive Home Terminals</u>

During the 1970's, advances in electronic technology in the areas of integrated circuits, displays, communications,

and magnetic recording technology will make technically possible economic interactive home terminals. The potential exists to provide the neighborhood information center or the home with the capability for accessing a vast amount of information from computer stored files or library-like sources.

There are many possible alternatives for technology and function in interactive terminals. One of the simplest terminals is the touchtone telephone which is coupled to a computer system with voice answer-back feature. Beyond this there are combinations of keyboards, light pens, printers, TV (black and white or color) and plasma panel displays, and electronic logic and storage which can provide a wide range of services at the terminal. Industry is developing this technology.

In general, function will be related to cost, with simple alpha-numeric type displays costing less than those for graphics or telvision type presentation.

A possible version of the interactive home terminal might take advantage of the television set and telephone which are already present in most homes and interconnect them with an acoustically coupled storage-display control device. Messages from the user to the computer would be entered by way of the telephone handset (touchtone or dial). Data from the computer files would be received via the acoustic coupler, stored, and converted to the proper format for display on the television set.

A simple but effective technique for presenting information with this system is that of menu selection. That is, with each incoming frame the user is asked to select one of up to ten alternatives to further define his desired information. For example, let's assume the subscriber wishes travel information. With the first frame he can select his desired mode (air, bus, train, taxi, etc.). The second frame, assuming air travel information was requested, would let the user choose the airport from which he wanted to depart. The third frame would specify the destination, etc., until the user had displayed on his screen the schedule of all airline flights of interest to him. Although very simple in concept, this technique is surprisingly powerful; it could, for example, allow a user to receive a single item of information from a million item file, making only six requests.

Telephone lines are the only readily available two-way communication media for home services at the present. A user would dial the computer information source and interact with it over the telephone circuit. The possibility of providing

voice as well as digital information could add an extra dimension to the visual display. Video-phone in the future will add a limited home video feature to the telephone network.

The use of a broadband cable system as the communications vehicle could provide full video. The use of existing CATV systems would require the addition of limited two-way transmission capacity. With users sharing a video channel, there would be the possibility for opinion polling and consumer surveying. This factor alone could justify the increased costs of using CATV for such home services.

The ability to poll individual terminals from a point on the cable system makes it possible for individual terminals to communicate directly with a central computer or to communicate with each other. At this time, there are only a few experimental limited two-way CATV systems in this country. Experiments using CATV channels will require exploitation of this limited CATV capacity, or simulation of the feedback mechanism by use of telephone lines.

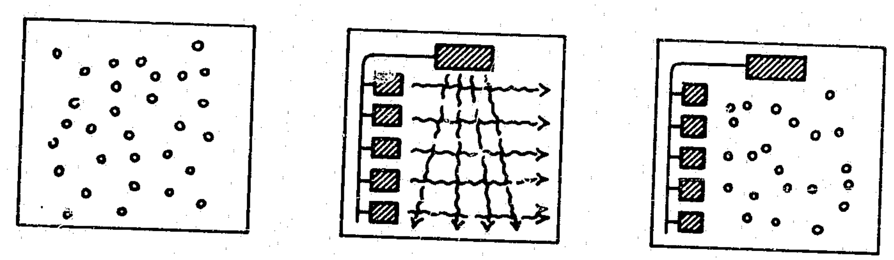
Future Concepts

In planning for the future role for telecommunications in the city we would suggest "organizing" one's thinking into viewing the city as a large information processing system in which much of the work going on is in the access, processing, and exchange of information either for direct use or for indirect service to the physical functioning of the city.

In this section we will be exploring the theoretical possibilities for improving cities through improving their capacity to operate as an information processing center -- that is, moving information rather than men and materials. If we can do that, then cities might become assemblies of neighborhoods as envisioned by Toynbee, as noted in Chapter I.

If we were to approach a city as a singular totality of its inhabitants and then overlay an organizational structure to provide specialized service, we would risk chaotic informational feedback and response, as depicted in Figure 1.

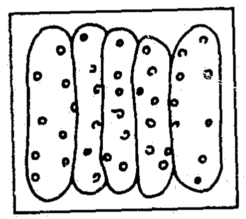
Figure 1



The people could either respond and react to the services rendered or march on down to general "headquarters" to demand that their personal one-millionth share of the city's total problem receive its due attention.

By thinking of cities as a confederation of neighborhoods sharing facilities and services (see Figure 2), we can start to provide some order to the flow of feedback information.

Figure 2



Amplifying the consequences of this approach, here is what we envision as the total information network structure (see Figure 3).

Overlaying this conceptual information framework, there are many shared physical networks that now provide a means for management, services, coordination and feedback to take place. For example, there is the network of streets and public transportation by which people carrying or seeking information move to points of access. There is the telephone network, available as an alternative when the informational content is low. There are the private communication networks of two-way radio used so effectively by police, fire, street maintenance, emergency services, etc. And there is the general one-way informational network of TV, AM and FM broadcast, providing information on items of special interest and importance to the city public.

These networks are vital to the city, as a nerve system is vital to the body. Each needs special planning and attention to see that it extends throughout the body and grows to meet increasing expectations of the public. But out ahead, in the field of telecommunications, there are some great opportunities coming to provide for significant improvements in the flow of information throughout the city. As an assist in thinking ahead we would suggest structuring ideas and plans for nonmobile services in terms of four basic telecommunication networks.

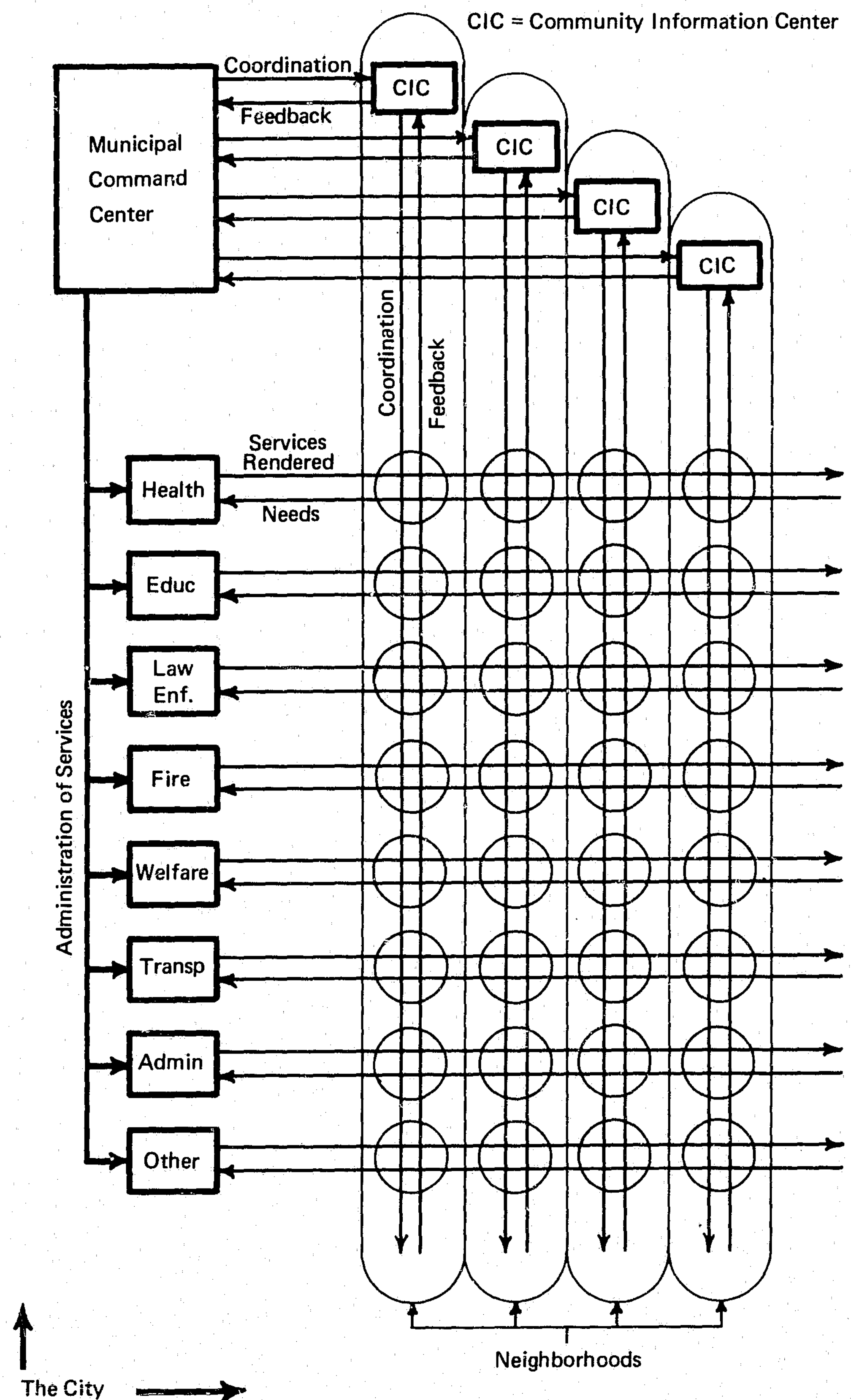


Figure 3

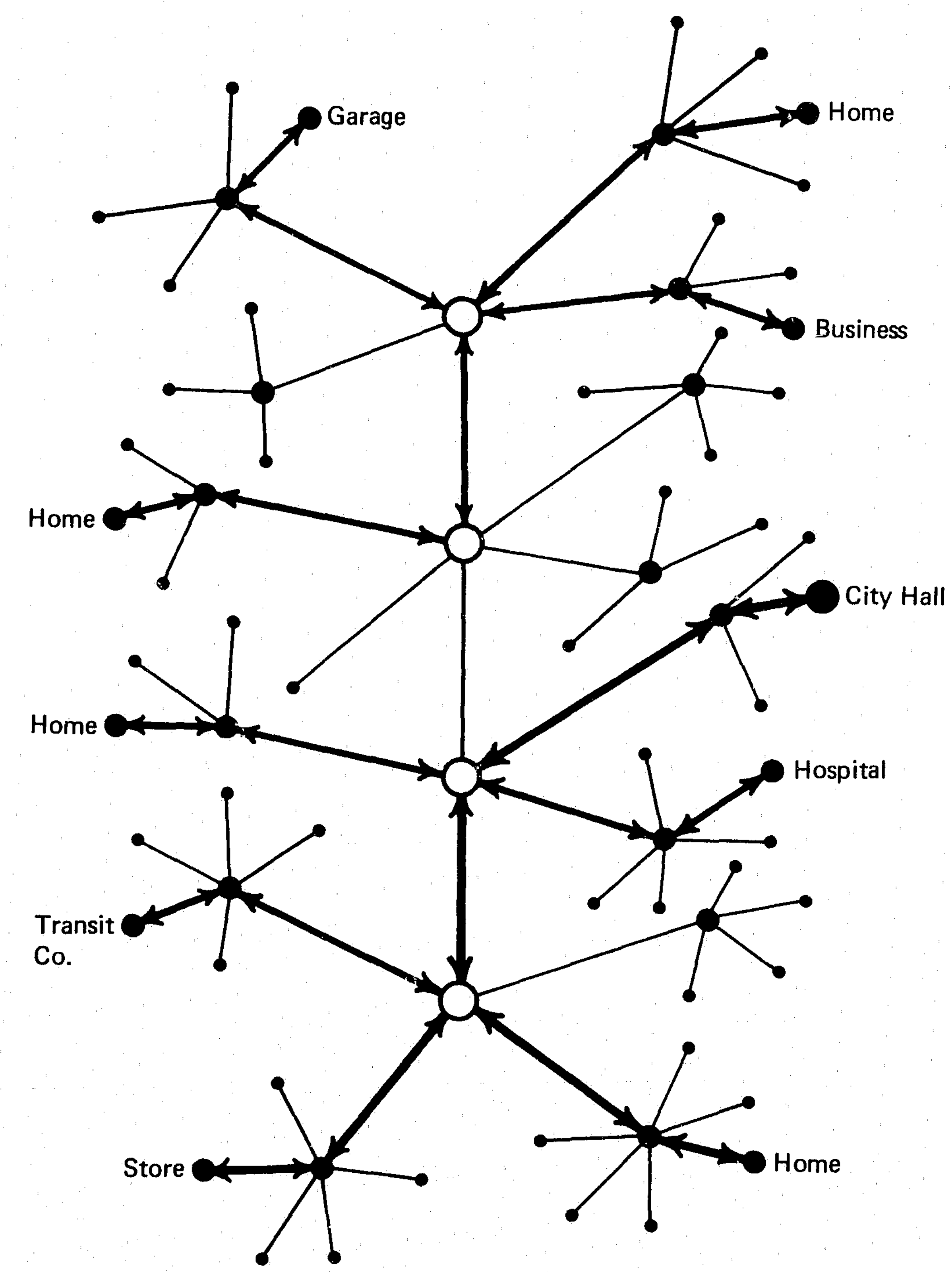
While we will discuss each as though it were a totally independent physical entity, we would note that in real life, there would be many opportunities to combine physically the conduits, cables or even electronics that comprise these networks. But separating them functionally is important as a first step in planning. Once the planner decides the extent to which he wants the various individual network functions to be available, then he can consider how they might be combined for economic gain. We would caution, however, lest excessive attention be given to this latter step at the expense of valuable time in seeing that the new services can become available at an early date.

Network Number I

The primary public network already exists, but should be directly encouraged to expand at a still greater pace. Here we refer to the present telephone system, a full two-way random access network that can accommodate voice and data. In the near term it will be broadened to include two-way video-phone (see Figure 4). This network is the most basic urban "nerve system." It is every bit as vital as streets, water, or power. Its basic attributes are its ability to put anyone in personal touch with any one else quickly and reliably -- no matter how great the distance, how dark the streets, or how heavy the traffic. With the advent of data processing, this same nerve system can provide similar random access among man and machines, or between machines. This network can be looked upon as providing a pipe into every home, office, or library through which one can not only converse, but also transmit written materials, photos, etc. The planner must remember, however, that it is the random access switching capability of the network enabling any terminal to interconnect with any other that is its most fundamental contribution.

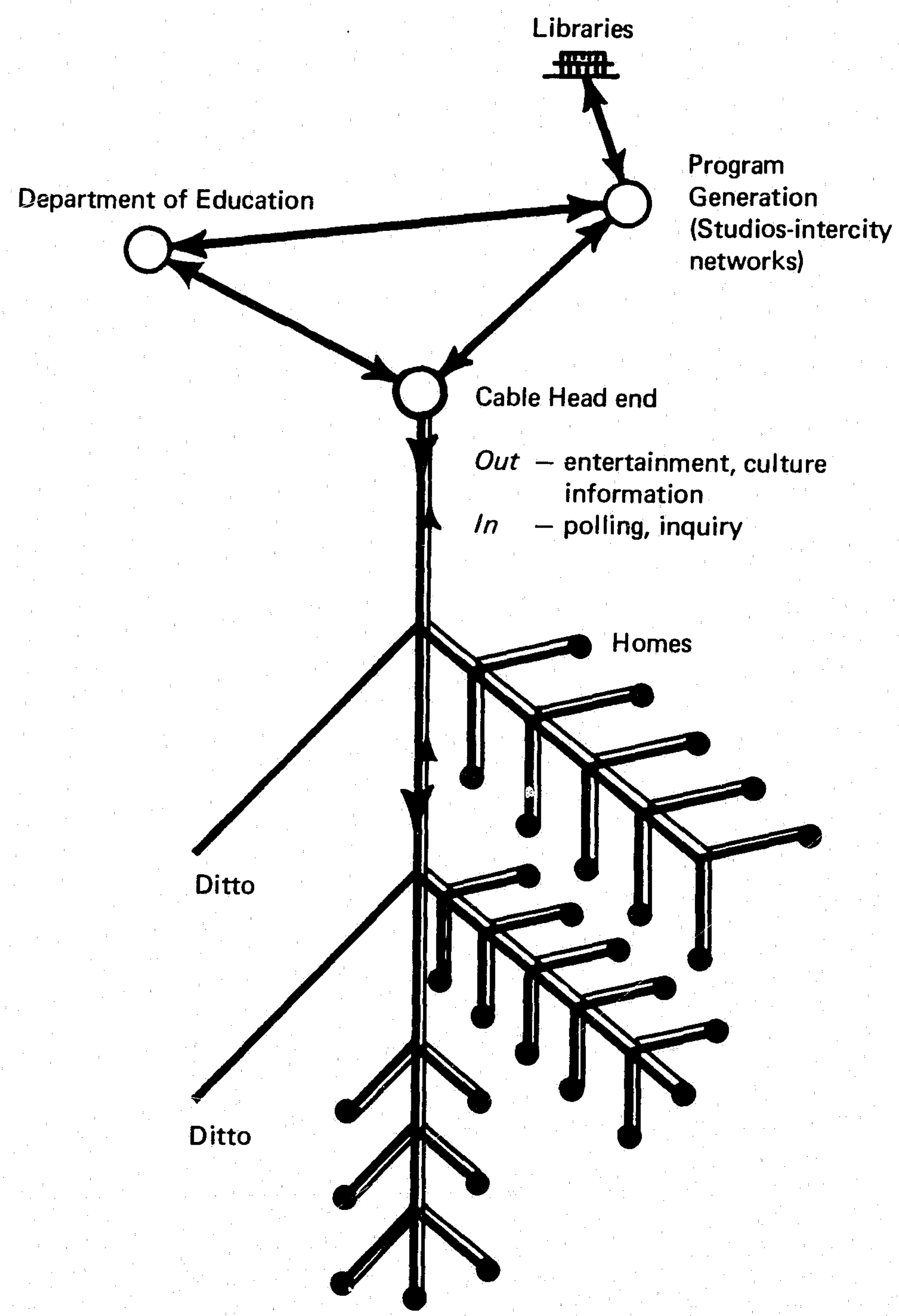
Network Number II

A second network would take over the task of distributing information in bulk from central facilities to offices or homes (see Figure 5). It would, in effect, be an alternate means for receipt of information now arriving via books, magazines, records, advertising, off-the-air TV, FM or AM radio, etc. This network is envisioned as a very broadband information pipe with a capacity of up to an equivalent of 30 TV program channels. It would also provide for limited address narrowband call-back for use in polling or making requests. By designing such a network to have subcenters at the neighborhood level (perhaps 3,000 to 15,000 homes), it would be quite possible for a neighborhood to cater to its own programming requirements.



FULL TWO-WAY SWITCHED VOICE
(later full two-way switched voice & video)

Figure 4



30 CHANNEL VIDEO DISTRIBUTION
WITH LIMITED ADDRESS NARROW BAND
CALL BACK

Figure 5

Network Number III

A third information network foreseen in the future development of cities would be a very broadband "pipe," carrying up to 30 equivalent TV channels in both directions, interconnecting the major public institutions of the city, including:

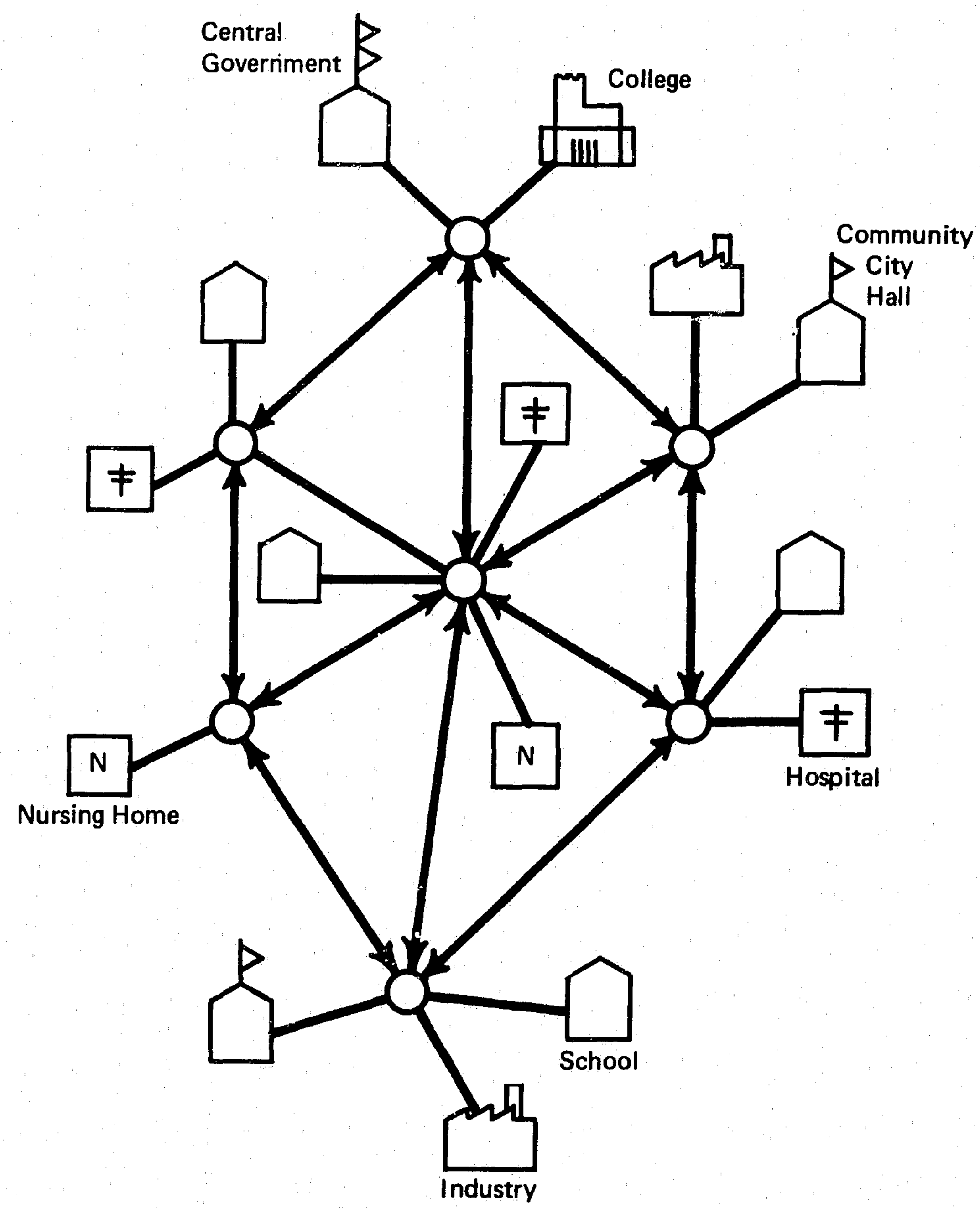
- city halls (municipal command centers and community information centers)
- hospitals
- nursing homes
- schools
- colleges
- libraries
- police stations
- fire stations
- bus stations
- railroad stations
- airports

Many of the channels on such a network would be permanently patched to interconnect certain institutions, but others would be patched-in either on schedule, or demand (see Figure 6).

Network Number IV

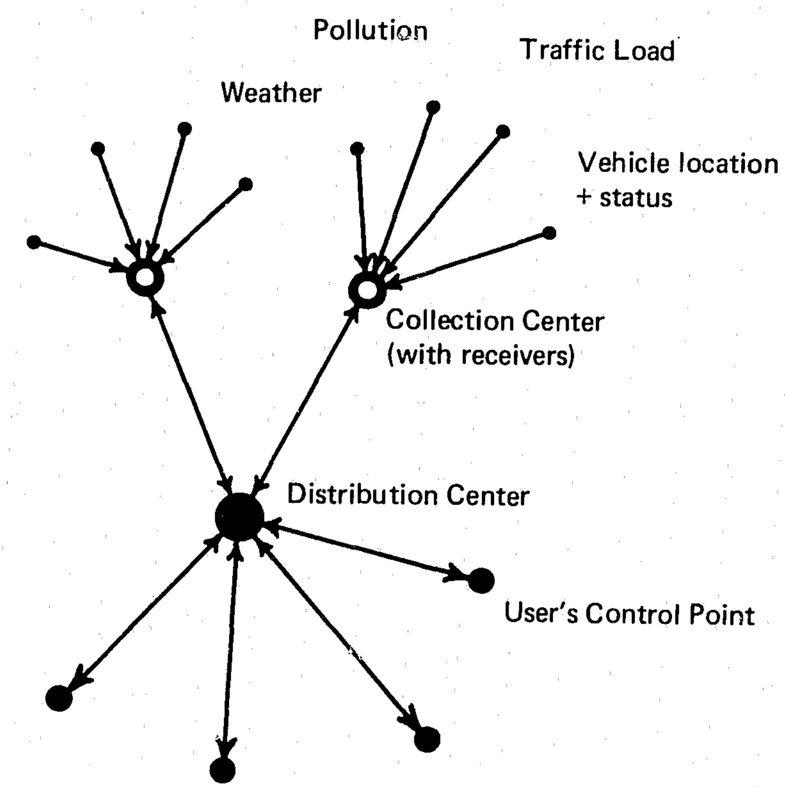
A fourth network would represent the sensing nerves for the city (see Figure 7). It would be a commonly owned network to provide information to key locations regarding such critical matters as:

- weather
- pollution
- traffic
- bus location and loading



30 CHANNEL TWO-WAY VIDEO
WITH LIMITED ACCESS + LIMITED
SWITCHING CAPABILITY

Figure 6



ENVIRONMENTAL STATUS
REPORTING NETWORK

- patrol car location
- highway, power, water, or sanitation maintenance status

Some of these are provided for today on lines leased from the phone company, or initially installed by the city. But there is need for much more information, more accurately determined and better displayed. The economics of such a sensing network which requires only minimal bandwidth per sensor becomes significantly more favorable when planned so as to combine many needs.

Relationship of Pilot Projects to These "Networks"

In Chapter III many pilot projects are suggested and each one in some way depends upon at least minimal existence of at least one of these basic four networks, except, of course, the radio propagation study recommendation. Table 1 provides a listing of those relationships. It should be quite obvious that while no one project may support its particular network, the total benefits to be derived from many projects certainly can.

Summary Comment

The technology to build these networks is well in hand. In the following chapter we will identify some very real human needs based on operational procedures that could be better served if such networks were fully available. But lest the reader depart from this chapter thinking that economics would prevent adoption of this "information processor" concept of a city, we would make these observations.

Consider a city of 500,000 inhabitants and an area of 100 square miles. The investment in the full two-way switched voice and data network for such a city already installed would run somewhere between $100 million and $200 million. By comparison, none of the other three networks proposed would cost one-tenth as much. And in comparison to construction costs for other urban facilities, each would cost less than the parking and access ramp space for 5,000 cars; or less than 10 miles of super-highway.

With regard to the service of communications technology for improved urban living, a big hurdle to overcome is economic; but an even greater one may be accommodation to the challenge of changing concepts.

TABLE 1

Project	Network I	Network II	Network III	Network IV
Municipal Command Centers	x	x	x	x
Community Information Centers	x	x	x	x
Two-Way Educational Delivery Systems	x	x	x	
Telemedicine	x	x	x	
Nursing Home Care	x		x	
Pollution Sensor Development			x	x
Transit Information System	x	x	x	x
Transportation Transfer Facility			x	x
Automatic Vehicle Monitor System	x	x	x	x
Transportation/Communications Alternatives	x	x	x	
Automatic Location Identification	x		x	x
Urban Security System	x	x	x	x
The Cities of the Future	x	x	x	x

CHAPTER III

COMMUNICATIONS PROJECT RECOMMENDATIONS

Introduction

This chapter describes pilot projects recommended by the individual subpanels to the federal government for its support and implementation. The subpanels are indexed on pages xv and xvi. The outline of each project is the work of the members of each subpanel who are identified at the end of each section. They were supported by staff members of the Committee.

It should be noted that the study of the Committee has been subdivided into functional subpanels for convenience and, similarly, projects have been described individually to assure clarity. As is explained in Chapter II, the projects themselves can and should be considered as part of the total city communications system; their implementation would be most effective if pursued on an integrated basis. A city with a cable television system which has a portion of such system capacity assigned to public services has an excellent opportunity to use this portion of its system for integrated project implementation.

In Appendix C is an analysis of city reactions to the project concepts. Data have been summarized on the basis of questionnaires to, and interviews with, municipal officials in a cross section of U.S. cities.

Citizen-Government Interaction

COMMUNITY INFORMATION CENTER

I. Objective

The principal objective of this pilot project is to provide city government information and personal services to all citizens.

II. Project Outline

A. Urban need -

Information centers would (1) provide a wider range of readily accessible city services and information to the citizen, (2) close the communications gap between the city administration and citizen, particularly the citizen in the inner city, and (3) provide the city administration with a ready source of information on citizen needs and problems.

B. Pilot Program Description -

The pilot program will have as its primary end result an operating community information center. The program will include six major tasks encompassing: preliminary design studies, system design, implementation, operational test, evaluation, and service expansion follow-on activities. Implementation of the pilot system will be limited to a single location. In addition, studies of system design and cost projections of a multi-location system will be carried out.

Possible services to be provided by community information centers include basically two types of functions. First is a referral function which is primarily directed at providing any citizen with information on procedures such as where to go or call to obtain the necessary service or information to satisfy his need. Second, the center may attempt to service the inquiry request, i.e. provide forms, brochures, specific information, or even physical services and ombudsman type assistance. The pilot program will concentrate on implementing fully the referral function. Studies regarding the implementation of service functions will be conducted; however, partial implementation will be a secondary objective.

1) Milestones -

The tasks to be accomplished during the pilot program are:

a) Design Study - this task will identify information and interfaces between citizens and the local government agencies. A classification scheme or other suitable access technique will be devised and system capacity will be determined.

b) System Design - the hardware system configuration will be determined and equipment procured. Software will be developed and test and evaluation procedures specified. An operator training program will be developed.

c) System implementation - equipment will be installed, tested and debugged. Operators will be trained.

d) Operational Test - the system will be placed into service with trained operators. Performance will be monitored. Software may be modified in one or two stages to incorporate improvements, or expanded services determined after the design study.

e) Evaluation - the system will be evaluated according to criteria developed in Task 2. Suggested criteria are discussed below.

f) Service Expansion - improvements in the system and expansions in the service functions area will be studied. In cases requiring only software or minimal hardware changes, these might be incorporated during the test program. Design and cost projections for the final multi-location system will be carried out. This task will probably result in a proposed expansion of the system, further tests, and added functions.

2) Program Schedule -

The duration of the pilot program is anticipated to be 30 months. The duration of each task is estimated below. These are serial times on the critical path and hence project milestones. Of course, some efforts including all of those related to Task VI are conducted in parallel.

Task I	-	6 months
Task II	-	9 months
Task III	-	3 months
Task IV	-	9 months
Task V	-	3 months
Task VI	-	slack path
Total	-	30 months

3) Location -

The project should be located in a major urban area. The neighborhood location should be in a community of moderate to low income families. Areas composed predominantly of welfare families should be avoided to eliminate a biasing of the entire project toward servicing welfare-related inquiries. In the cost estimates below, no cost has been estimated for siting of the project. Housing the project in an existing public building may or may not be feasible depending on local circumstances.

4) Evaluation Procedure -

A major task of the project will be to develop evaluation criteria. This is not likely to be an easy task due to start up transients and depending on the publicity received and cooperation afforded to the program by both citizenry and local government. Possible evaluators and criteria could be selected from among:

a) statistical sampling of citizen (user) reaction by questionnaires and/or interviews.

b) record-keeping within the project to track inquiry frequency, nature of inquiries, and incidence of repeat inquiries.

c) analysis of experience of local government agencies before and after initiation of the project. This source may not be generally useful in the event that the pilot program has too small an

effect on the total communications load to be significant. However, some analysis of identified referrals is possible with local agency cooperation.

The principal benefit of this system is a social service. It may not be cost/effective except in the most general sense, which includes the cost incurred by citizens in wasted telephone calls and travel. For government, it may be an added cost. However, cities soon will be implementing new concepts for handling all operational details of city administration under the HUD Integrated Municipal Information Systems program. The decentralization of the government interfaces with the citizens could well be an important element of the restructured organizational administrative systems. The final evaluation then will relate the costs of service rendered to the citizens to the new operational system. Therefore, no opportunities to cancel or redirect the project based on factual information will exist until the end of the operational test (end of program).

5) Cost -

The cost of the pilot program has been estimated based on the scope described above and the following:

a) a minicomputer with disc operating system will provide the needed computer capacity. This approach is much more flexible than planning for the use of time-shared service on a large machine. In comparison with purchased time shared service it will also be cheaper and more predictable. Purchase is assumed, though rental could be considered. If purchased, the equipment would be available for follow-on activities determined in Task VI. If not, residual value would be an asset to be disposed of.

b) all hardware is standard; no hardware engineering services are needed.

c) no back-up hardware is considered in the pilot, though it might well be in a final system, especially if the final approach involves a central machine(s) serving several offices.

d) the pilot system has been assumed to have six information service operators. The hardware will handle several times that number or less as required. These operators will operate the system and counsel citizens making inquiries. They might properly be employees of the local government, however they have been included in the cost estimates as contractor personnel. Should more than six or less than six operators be desired, the cost estimate below may be adjusted up or down by $28,000 for each operator and corresponding computer access terminal.

The major costs will be in personnel costs. The project team is estimated to require five permanent party personnel (30 months), three specialists for 18 months or less, and six information service operators for 10 months. These were estimated at a total contractor price, including overheads, profit, administration, etc., as follows:

<u>Personnel Costs</u>

1.	Project Director - $5,000/mo. for 30 months....	$150,000
2.	System Analyst - $4,000/mo. for 30 months......	120,000
3.	Operations Research Analyst - $4,000/mo. for 30 months........	120,000
4.	Analyst/Programmer - $3,500/mo. for 30 months..	105,000
5.	Clerk/Typist - $1,500/mo. for 30 months........	45,000
6.	Operations Research Analyst - $3,500/mo. for 18 months........	63,000
7.	Operations Research Analyst - $3,500/mo. for 18 months........	63,000
8.	Human Factors Specialist - $4,000/mo. for 16 months........	64,000
		$730,000
9.	6 Information Service Operators - $2,400/mo. for 10 months....	144,000
		$874,000

<u>Traveling Expenses</u>... $ 20,000

Hardware Costs

Units		
1	Minicomputer with communications interface of Honeywell H316 or DEC PDP-11 class.........	$ 18,000
1	Bulk storage disc or drum, approximately 2 megabit capacity............................	10,000
1	Hi-speed paper tape reader/punch...............	6,000
1	ASR 33 teletypewriter with punch/reader........	1,700
6	Buffered cathode ray tube terminals............	24,000
	Data sets	9,000
	Installation	6,000
		$ 74,700

TOTAL PROGRAM COSTS......... $968,700

6) Related Programs -

It has been suggested that the municipal command center could be expanded to provide for the storage and distribution of information to the community information centers. An examination of the shared time approach utilizing a large frame computer compared to the mini-computer application for specific jobs, suggests that the mini-computer approach provides much greater flexibility with fewer restraints on the processes of updating and modification. It is recommended that the community information center be developed as an independent information processing system.

Perhaps it should be noted that in the future city where wide band cable connections were provided to all homes with narrow band response connections*, the information center could become a regular "dial-for-information-service", with information display available on the home TV or home terminal equipment.

7) Growth Potential -

The cost estimates provide the necessary information required for projecting the implementation of any number of additional terminal centers or community centers. Presumably, the high priority extension of additional terminals would be directed toward service in the poverty areas.

*Interactive Home Terminals, op. cit., pages 23-25.

Community Information Centers

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* * *

Subpanel on Administration and Emergency Services: Daniel E. Noble (chairman), George R. Rodericks, and Richard C. Hopkins (staff).

TWO-WAY EDUCATIONAL DELIVERY SYSTEMS

Introduction

In searching for new approaches to the provision of urban educational services we have set as a goal increasing the quality and availability of education for all who desire it. Too few adults in our urban populations have exposure or access to ongoing education. Estimates of the level of adult illiteracy in disadvantaged areas range as high as 50%. Performance standards in many urban public school systems are too far below average. Dropout rates and absenteeism testify to the shortcomings of formal education in our cities and the cost of education is rising rapidly.

There are new potentials for improving the educational processes of our cities. These are closely linked with the advancing technology of broadband cable communications and the use of the computer as a cost effective educational tool. Of particular importance to urban education is the capability of this technology to provide services to large numbers of geographically dispersed people on an individualized basis. The availability of low-cost communications channels and provisions for student interaction with educational materials promises to add a new dimension to urban education.

Outlined below are several projects which would examine the educational benefits to be gained from the utilization of advancing computer and cable technology. The questions which would be answered through these experiments could be of significance to policy makers on both the federal and local level.

We have identified three specific applications to serve as the focus for development and demonstration projects:

1) Interactive Instructional Television

2) Interactive Community Information Retrieval

3) Computer-Assisted Instruction

INTERACTIVE INSTRUCTIONAL TELEVISION
(Two-Way Educational Delivery System)

I. Objective

To determine the effectiveness of various forms of two-way interactive instructional television in improving the quality and distribution of educational services among the urban population.

II. Project Outline

A. Background

One-way instructional television (ITV) has been effective in teaching a wide variety of subjects to a wide variety of student populations, with Sesame Street perhaps the best known example. However, programming of this type lacks the dimension of direct student interaction.

An element of student interaction can be added to one-way ITV in several ways. For example, a small studio audience can serve as proxy for a much wider audience to ask questions and provide other forms of interaction with the instructor. Also, arrangements can be made to obtain feedback from students after they have viewed instructional TV material.

Recent trends in education have emphasized the importance of student interaction on a more continuous basis. ITV with audio return channels offers the opportunity for students in remote classrooms to ask questions and to join in the discussion on almost the same basis as students in the classroom with the instructor. Systems of this type with audio response are in operation at the University of Florida, Southern Methodist University, and Stanford University.

Recent developments in Subscriber Response Systems for cable TV (see pages 21 - 25 and Appendix A) offer very large groups a way to interact on a limited but more or less continuous basis throughout an ITV program. All viewers see the same picture on their TV sets at a given time and each viewer has a twelve-button response pad with which he can respond to questions posed by the instructor. A computer polls the students every 10 seconds or so to

pick up their responses. Responses of the students to a given question can be compiled in the form of a histogram which would show the number of students selecting each alternative in a multiple choice situation. The teacher could use this information to guide the speed and content of his presentation, possibly repeating or restating material not understood by his audience.

For example, university or continuing adult education classes with this type of student interaction could be delivered to large numbers (thousands) of students in their homes simultaneously. High school teachers offering special material of interest to only a few students in any one high school might provide simultaneous classes to students at many high schools in a metropolitan area. Classes might be offered to off-duty firemen, policemen, nurses, or other public employees in their place of work.

Subscriber response is being provided for commercial reasons in many new cable systems and can be retrofitted into older systems by installing new crossover filters and two-way amplifiers. Within the next five years a significant fraction of the American public will have this capability even if no public action is taken. It is the purpose of this project to determine the value of subscriber response systems for educational purposes. If the concept is as promising as it now appears, a study should be made to determine the best means for making services of this type available to all who wish it throughout the nation's cities.

B. Scope

To assess the usefulness of subscriber response in instructional TV systems the first step is the preparation and evaluation of program materials expressly designed to use this feature. Provision should be made for experiments at all levels of education, from pre-school through university graduate school and continuing adult education. A variety of approaches should be sponsored to explore creatively the possibilities of the new medium. The nature of instructional TV programming will be substantially altered by the addition of active student involvement. A "two-way Sesame Street" would require the use of new techniques on the part of both producers and teachers.

Beyond developing new course materials, it will be essential to conduct comparative studies of this approach, comparing it with other ITV approaches. Cost and

effectiveness comparisons are needed in order to proceed sensibly with national education policy. If the approach proves effective at reasonable cost, an important and critical factor is that service can be made available to all urban homes, offices, and institutions.

C. Implementation Details

1) Programs

The project can be divided into three phases. In the first phase, program materials will be developed which match the needs of the local community. In phase two, initial implementation of programs and concurrent evaluation will provide data on the effectiveness of the educational services. Phase three will involve program redesign according to evaluation results, cost studies, and planning for wider development and distribution for large scale follow-on testing.

2) Implementing Organization

Depending on the level of instruction, e.g., pre-school or adult education, different sources of educational materials may be appropriate. Some universities with experience in ITV programming and related techniques would be appropriate sources of new materials at all levels. Schools of Education would be potential sources of materials for school-age children.

3) Time

Two years is probably reasonable for this project, assuming that course development and testing take place with only a small group of students. A longer time would be required to bring programs into an urban community for evaluation with large audiences. Probably such city-wide tests should be part of a separate follow-on project that would take place after initial courses have been developed and successfully tested.

4) Location and Hardware

Assuming that only a small scale project is planned initially, location will depend only on the availability of hardware equivalent to what would be used in a real city environment. In a follow-on project to use a real cable TV system it is suggested that two factors be taken into special consideration in location selection.

First, a mix of racial and socioeconomic levels should be represented in the subscriber population. It is important that the techniques demonstrated be evaluated to show their effectiveness upon the varied segments of the urban population.

Secondly, from a technical point of view, consideration should be given to the capabilities of the cable TV system to which the project will be closely tied. The availability of channels for educational services and the ability of the system to provide "upstream" channels should be important criteria.

Hardware required in addition to the cable network:

- Computer at head-end for basic polling and channel control. Subscriber requests for special services and responses to inquiries initiated by this computer will be stored and processed by it.

- Twelve-button pads and local digital memory at each terminal location. Possibly teletype terminals at some locations, especially at community centers. Converters for receiving some pay-for-service or other "private" channels must be controlled from head-end by means of data signals. The computer must be able to send low data rate messages to individual subscribers, both to query (poll) for messages and to control subscriber converters.

5) Evaluation

Parallel to each phase of implementation an evaluation group should monitor the effectiveness of the program in bringing educational services to the target population. Success will be determined by: (1) the provision of cost-effective educational services, and (2) the acquisition of information needed by policy makers to decide whether and in what form to offer this service on a wider basis and how expansion of the service might be accomplished.

6) Costs

The dominant cost of an instructional TV system is that of software and programming, just as in entertainment television. There is a very wide range of possible software and programming costs, even for a well-defined course with a given basic content. In the following, estimates are given for two different possible project configurations with a range of programming costs indicated. As a reference point, an hour of entertainment television with

well paid actors, but not expensive stars, and no expensive outdoor scenes costs roughly $30,000 according to informal comments from industry sources. The production cost of taping a one-hour show, apart from the costs of actors, writers, etc. is estimated at about $3,000. This figure of $3,000 per hour covers cameramen, directors, script writers, etc. Another figure of interest is the cost of operating a studio with a camera which could be used to view an instructor in a classroom setting. The cost for this service is in the range of $30 to $300 per hour. From these rough figures we see that the cost of creating high quality new material for instructional TV services especially adapted to two-way learning is likely to be in the range of $3,000 to $10,000 per hour or more. The only way that programming of this quality and cost can be justified is through large audiences, just as in the case of entertainment TV. However, advertiser-supported entertainment must operate at a cost of less than 10 cents per viewer hour, whereas it may be feasible to collect up to $3 per student hour for high quality instruction. Therefore, an audience of 10,000 can support a programming cost of up to $30,000 per hour for instructional material. In present universities costs per student hour are typically $3 or more per hour, but the number of students is typically only 30, allowing a cost of only $90 per hour which severely limits the amount of effort that can be put into an hour of instruction. Public school instruction is provided at around 30 cents per student hour in classes of around 30, with even more severe constraints on the amount of effort that can be applied.

In the following two-year project cost estimate it is assumed that the software and programming costs are in the $3,000 to $10,000 per hour range. Hardware costs are estimated for a 100-terminal pilot system that must be built up from nothing.

Course development and evaluation for four 30-hour courses at $3,000 or $10,000 per hour	$ 360,000 or 1,200,000
Hardware	
Head-end costs	
Studio and equipment*	350,000
Computer	50,000
Terminals and distribution	
100 black-and-white TV sets*	10,000
Cable distribution to classrooms or other locations*	10,000
100 12-button pads and local memories	30,000
Installation and experimental modifications	150,000
	$ 600,000
Cost analysis and planning	40,000
TOTAL:	$1,000,000 or $1,840,000

It is recommended that several such projects be funded at different institutions in order to obtain different

*Items with asterisks might be available in some universities or other locations where a pilot project of this type could be developed. In this case, a cost reduction of perhaps 20 to 30 percent might be possible.

viewpoints and try the concept out at several levels of education from pre-school through continuing adult education. The follow-on to these curriculum development projects should be a number of trials in operating cable TV systems. It is difficult to estimate the costs associated with a follow-on project at this time. However, if it is assumed that all hardware is provided by the cable system for other purposes and that the software is developed under the above pilot program, the only additional costs should be for evaluation. These costs might be covered by charges to students; but, in any event, it appears that the follow-on phase will be a relatively low cost one. Plans for the follow-ons should be developed as a part of the initial course development projects described here.

Interactive Instructional Television Bibliography

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Education

INTERACTIVE COMMUNITY INFORMATION RETRIEVAL SYSTEM (Two-Way Educational Delivery System)

I. Objectives

A. To determine the types of information that, if provided on a rapid access basis to urban residents, would be widely utilized.

B. To determine whether or not such services could be economically provided by means of a cable TV system with a subscriber response feature, and storage for a single TV frame at each set.

II. Project Outline

A. Background

Three other projects in this report have identified information needs of citizens that are not now being adequately met: (1) the municipal command center; (2) the community information center; and (3) the improvement of urban transportation. Up-to-date information on emergencies, city governmental functions, and transportation schedules would probably be widely used. There are many other classes of information that citizens would make heavy use of, if they were readily accessible. Examples are educational materials, bibliographic information, TV schedules, movie and sports schedules, vacation and travel information, welfare and social security information, certain classes of product information, and political information of many types. Some of this information may be supplied by commercial entrepreneurs. Legal and political questions will have to be resolved before some information can be made available. A careful study of these possibilities and problems is required.

Technology for making alpha-numeric information available on an individual basis to the cable TV subscriber on his TV screen exists today (see Appendix A). This technology allows the subscriber to call up information through his subscriber response pad. A computer at the head-end stores the information and transmits it to the subscriber over a regular cable video channel which is time-shared with a number of other subscribers. Out of a group of 10,000 subscribers, 300 might wish to use this service simultaneously at a particular time of day. Since a single frame of TV

contains all the information desired at one time by a subscriber and requires only 1/30 of a second to transmit, one channel shared among these 300 users would provide each user access to a new frame every 10 seconds on the average. Many users might wish to view frames for periods much longer than 10 seconds and hence would not experience any waiting time. A system of this type requires local storage of one TV frame the cost of which is at present uncertain. However, it is likely that local storage of this type will be available at less than present TV set costs in the near future.

B. Scope

This project should assume that the technology for providing low cost single-frames of TV to home users via cable TV will be available. The project should aim at an understanding of the information needs of urban dwellers that could be met on a cost-effective basis by a computer-based system operating through cable TV. Only certain types of information that are likely to change rapidly with time are to be provided in this manner. Thus this project is not aimed at making the public library available over cable TV, even though the services being provided are library-like in nature. The problems associated with making very large data banks (such as the information of a total library) accessible in this manner at low cost are primarily those of indexing, storing, and rapidly accessing data. These problems are not likely to be solved within the next few years. However, it is not necessary to solve these problems in order for this project to work, because the amounts of data required to be stored will be quite modest.

The project should include a detailed analysis of the legal, political, social and economic factors involved in the provision of each of a variety of information services. Public policy issues are likely to arise in connection with many of these services and these issues should be identified and analyzed.

C. Implementation Details

1) Programs

A two-phase program should be planned. The first phase should be a relatively short study of information needs and service design alternatives. The second phase should be an experiment aimed at supplying a set of

information services to a specific community.

2) Implementing Organization

A non-profit research institute or a university might effectively carry out the study phase. In view of the diversity of service possibilities, a multi-disciplinary approach would be appropriate. The second phase would involve a city government, the local cable TV franchise, and might be implemented by a variety of different organizations.

3) Time

The first phase should take about six months. A continuing program of study and evaluation should accompany the second phase which might be expected to take two years.

4) Location and Hardware

The first phase involves no location or hardware problem. The second phase should be conducted in a location where a limited two-way cable TV system is in operation. The single-frame channel time-sharing equipment for some number of terminals, such as 100, may have to be financed for the first experiment. However, a meaningful experiment cannot be conducted without thousands of terminals so-equipped. Since the timing of the development of this hardware is so uncertain, no attempt is made to specify how this hardware should be supplied.

5) Evaluation

Evaluation becomes a key factor in the second phase. It will be critical in this project to test the willingness of users to pay for the service. The actual usage of each service and possible changes in citizen behavior as a result of better information need to be monitored. For example, if transportation schedules are made available, both the usage of the schedules and the usage of the transportation system should be examined.

6) Costs

We estimate that the study phase can be carried out for under $100,000. The costs of the second phase are extremely uncertain, both because the hardware timing is uncertain and because the costs of software development are uncertain for new services of this type. An objective

of the study phase should be to estimate the second phase costs as a function of the services to be provided.

D. Related Projects

The CAI Project is very closely related to this project because both systems require terminals with local storage capability and both can use identical keyboards. There is a possibility of offering both services in a single cable TV community project at a modest additional cost, and the problems associated with a joint project of this type should be explored. For example, a 10-second average response time, as discussed above, is too long for CAI. CAI requests for service might be given priority over other requests for service in order to provide the needed response time in a system with 300 users sharing a channel, or alternatively fewer users might share a channel if CAI service if offered.

See also the Municipal Command Center and the Community Information Center project descriptions.

Education

COMPUTER-ASSISTED INSTRUCTION
(Two-Way Educational Delivery Systems)

I. Objectives

A. To encourage and stimulate the development of computer-based education as a method for improving learning skills, especially among disadvantaged children.

B. To examine the potential for distribution of computer-assisted instruction services via the emerging broadband cable systems of our cities.

II. Project Outline

A. Scope and Background

The difficulties of providing quality instruction to the disadvantaged in the inner city are well recognized. Here, where individual attention is most needed, economic factors dictate large and often ineffective classes.

It has been suggested that the goal of individualized instruction, a goal discussed by educators for over a century, can be realized with the computer. During the past decade several projects have demonstrated that computer-based education has advanced to the point where it is now a powerful and versatile teaching/learning aid. Because of its unique ability to bring individualized instruction to the student in a completely interactive mode, there is real reason to believe that computer-assisted instruction (CAI) can be usefully applied to many educational problems. Such a premise requires little substantiation from a technological point of view. Acceptability on the basis of social, institutional, cultural, behavioral, pedagogical, and curricular criteria will, however, require considerable and continuing educational assessment. As technology progresses and simplicity of function increases, many of the non-technical impediments will be overcome.

Not everyone shares this optimistic view of the potentialities of CAI. Indeed, many past efforts, a few of them ill-conceived by non-educators with limited insights into the learning process, have led to widespread disillusionment and even some hostility toward the computer as an educational tool.

It is paradoxical that the introduction of more and sophisticated technology, rather than depersonalizing the instructional process, can lead to a much closer and more personal teacher-student relationship. The teacher, freed from much of the routine and time-consuming presentation of facts, is available to the student to help with individual problems.

In the past the projected benefits of wide dissemination of computer-assisted instruction have been overshadowed by its exorbitant costs. Per terminal hour costs of $5.00 or more were common and are prevalent even at the present time. However, several groups now suggest that in the very near future these costs will become comparable with those of conventional classroom instruction, that is, less than 40 cents per student terminal hour. With adequate development support, the benefits of computer-assisted instruction seem within reach at a reasonable cost.

Programs to bring the promise of CAI to fulfillment have been underway for more than 10 years and hardware development is now well in hand. What is needed at this time is an intensive curriculum development program to bring the advantages of individualized instruction to the task of improving the reading and mathematical skills at the primary school level.

In a well-written CAI lesson the student participates actively, with complete absorption. By manipulating variables in models, the student can exercise his curiosity as well as learn at his own pace.

In the past CAI has been used mostly for drill and practice, and for this it is very effective. Equally important, however, is its use, through game playing techniques, in the development of critical thinking skills. An example of such a game played with the computer is the game of NIM:

First Display

Here are 9 sticks.

| | | | | | | | |

Take turns with me, taking away 1 or 2 or 3 sticks at a time. The one who takes away the last stick loses.

Then the computer and the student alternate taking away sticks. The program is designed so that the computer always

goes first, randomly removing 1, 2, or 3 sticks. If the student thinks ahead, he is in a position ultimately to win. However the computer is programmed to try to win (if it can) after the student's first move. At the primary school level, these interactive games are an important exercise in critical thinking, on an individual basis.

To develop the full potential of CAI in the elementary school setting, programming which goes beyond simple drill and practice must become available.

Closely related to the development of effective course materials are questions concerning the technical characteristics of CAI systems. Clearly the kinds of instructional programs which are delivered to the student depend in part on the characteristics of the particular CAI system.

Two principal CAI technology trends have emerged. They are: (1) the centralized large computer concept exemplified by the University of Illinois's PLATO project designed to serve 4,000 terminals from a central point and (2) self-contained decentralized CAI installations such as Mitre's TICCET, or the Computer Curriculum Corporation's small special purpose system which would use newly developed "mini computers" to support about 100 terminals. One cannot predict with certainty which of these two trends in computer based education will be dominant in the years ahead; it appears that both concepts have merit and justify continuing software development and utilization experience.

Apart from the centralized versus decentralized question, there are features which should be identified as desirable in the development of CAI systems. Specifically, a modern CAI system should provide:

- For both students and authors, quick response, full alpha-numerics, graphical and pictorial display with audio and a considerable amount of computer power for complex responses; for example, the ability to have the computer calculate correct answers and judge the students' responses accordingly.

- For teachers with no background in computer programming, the ability to write and edit lessons after only a few hours of instruction in, and work with, the author language.

Another important problem in the provision of CAI services is that of connecting the student terminals with the computer.

Unless the computer is located in the vicinity of the terminals, communications costs become significant. Communications lines must be either installed as a large capital investment or leased from common carriers.

The presence of cable TV systems with upstream channels may provide a significant cost saving alternative for the development and dissemination of computer-assisted instruction systems. One aspect of this project is to explore the possibilities for providing CAI services via a cable TV network with 2-way features.

A primary activity will be to determine which, if any, currently available CAI programs can be adapted for use on a limited two-way cable TV system. Bandwidth, computer characteristics, and terminal specificatons should be examined so that the constraints of using cable TV as the communication vehicle for CAI become adequately identified. In this portion of the project the current potentials for cable TV distribution of CAI programs would be illuminated.

There are several alternatives to the delivery of CAI services by way of broadband cable. Some of these are briefly described here.

1) Perhaps the simplest CAI service would operate with teletypewriter terminals. Because the required transmission rate does not exceed the capacity of an ordinary telephone channel, up to 1,000 terminals could be served by one video cable channel.

2) Due to limitations, including slowness and noise, the teletypewriter is often replaced by a conventional cathode ray tube (CRT) display. Without local memory or local picture refresh, each CRT terminal requires its own video channel. If, however, by means of appropriate additional hardware local memory or picture refresh is provided, then a low information transmission rate would suffice so that again up to 1,000 terminals could be served by one video cable channel. As long as CAI programs are restricted to alpha-numerics, that is, letters and numbers, the local memory requirements can be satisfied by commercially available units costing about $2,000.*

*A potentially low cost interactive terminal for simple alpha-numeric programs would link the already available touch-tone phone and a standard television set with an electronic control/storage device. This concept is described in detail in Chapter II, pages 23 - 25.

On the other hand for CAI lessons requiring graphics (the drawing of computer generated lines, curves and graphs), local memory requirements become large and expensive.

3) For advanced CAI systems incorporating graphics, one feasible approach is the use of video refresh units which allow updating of selected display points in the video frame. For economic utilization this arrangement requires that terminals be clustered in groups of approximately 100. In this case a small general purpose computer could be located on site with the terminals, thus limiting the need for broadband cable distribution.

4) A second economically feasible approach to providing an advanced CAI system with graphics is to use terminal displays with inherent memory. Here, inherent memory will mean that each point remains in a particular state until it receives a signal to change. With terminals such as the bistable CRT display or the plasma display panel, CAI services, including computer generated graphics, can be provided via an ordinary telephone line. Thus again, up to 1,000 terminals could be accommodated on one video cable channel.

It should be noted that distribution of CAI services via cable could bring about eventual delivery to the home. However, economic considerations dictate that initial experiments of this kind take place in schools or other institutions where terminals can be operated with a high utilization factor. The day of the individual interactive home CAI terminal is in sight, but is not yet upon us.

B. Project Implementation Details

1) Programs

The project can be divided into two programs.

a) <u>Course Material Development</u> - research and development of course materials for elementary math and reading. (Program 1)

b) <u>Broadband Cable CAI Distribution Study</u> - examination of the engineering and economic factors of CAI distribution via broadband cable. (Program 2)

2) Time

Program 1, for the development of course materials, would require approximately three years for completion. Program 2 would require only about one year.

3) Location and Hardware Requirements

Program 1

It will be important that the project be conducted where the course material authors have access both to a modern CAI system as well as a sample elementary school audience.

Program 2

An available modern CAI system would be required in order to experiment with various hardware configurations. Access to a two-way cable TV network would be desirable though not essential. Interface between the CAI system and the cable TV head-end does not appear to be a serious problem.

4) Costs

It is predicted that per student hour costs will be less than $0.40 when CAI is more extensively developed. This is ten to fifty times less than most CAI systems in operation today. Economic data available on present systems furnish good baseline information for costing such instruction.

Definite cost figures for each of the suggested programs relate to the level of effort and sophistication. For approximation purposes only the following estimates are given:

Program 1

Development of course materials in elementary education to stimulate critical thinking skills in math and reading is estimated to cost $900,000 for a rigorous three-year project.

Program 2

A one-year study of the engineering and economic factors of CAI distribution via broadband cable would require about $200,000.

C. Related Programs

There has been substantial effort in the development of CAI drill and practice programs for elementary school applications. However, what is recommended here would take a step toward bringing the full potential of CAI to bear on the problems of primary education. Use of the computer in the development of critical thinking skills is the unique approach of this project.

Many cities are currently under pressure to plan the future of broadband communications in their communities. Unfortunately the potentials of the new cable medium for useful educational services are not well known. This project would help shed light on the possibility for a widespread computer-based education service.

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***

Subpanel on Education, Training, Recreation and Culture: Edward C. Jordan (chairman), Joseph M. Pettit, Donald A. Dunn (consultant), William Sharp (adviser), Philip Weinberg (consultant), Stanley A. Garlick (staff).

Health

TELECOMMUNICATIONS AND MEDICAL SERVICES

Introduction

A major problem in providing good medical care -- whether to urban or rural areas -- is that there are a limited number of available physicians, particularly those who administer "primary" care. This is due in part to a limited supply of practicing doctors, in part to their unequal geographical distribution, and in part to sub-optimal utilization of available physician time. The scarcity of physicians is most obvious in rural areas where it is not unusual to find moderate sized communities which cannot attract even a single doctor. The maldistribution of physicians is most apparent in urban areas where large segments of the populace, particularly those in poor sections, are served by a paucity of overworked practitioners, while nearby large medical centers attract large numbers of physicians.

It is widely accepted that in order to improve the quality and availability of medical care for all citizens, new distribution systems must evolve. Such systems of medical care should significantly extend the service capacity of individual physicians both geographically and in terms of the number of patients each can serve. It is also generally agreed that one key to success in such systems lies in the more effective use of physician assistants and other allied health workers. Technology, particularly telecommunications and data processing, may play an important role in the development of innovative systems for providing medical care.

Communication systems should be considered as tools, and their utility will depend upon the organizational structure of the health care systems into which they are incorporated. The potential value of these tools for improving medical services is only incompletely understood at the present time, but should be experimentally investigated.

In accordance with the current trend, we broadly define telecommunications to mean not only the delivery of messages by electrical means at a distance, but also the electronic processing of information. Thus, the tools available to us are:

A. Electromagnetic transmission media

1) Narrow band wires, i.e., telephone quality
2) Wide band wires or cables, i.e., video
3) Broadcast (non directional) radio
4) Beamed radio or light signals

B. Communications Systems

1) Fully switched private lines, anywhere to anywhere -- the telephone system
2) Dedicated private links (narrow or widebands)
3) Mobile radio networks
4) Radio and TV broadcasting
5) "Broadcasting" by wide band cables (CATV)

C. Data processing systems

1) General purpose digital computers
2) Small special purpose computers

D. Terminal equipment

1) Telephone relaying of EKG's
2) Facsimile
3) Teletype
4) "Touch - Tone" signaling
5) Television
6) Message recording (magnetic, etc.)

The message routes, now in use or reasonably predictable are:

1) Patient - Physician (telephone) -- request for help, advice, appointments, etc.
2) Emergency -- patient -- police by phone -- police to squad car or ambulance by radio
3) Ambulance enroute to hospital (radio) -- description of patient -- instructions, where to go -- transmission of physiologic information
4) Physician - physician (phone) -- consultation -- remote EKG (electrocardiogram), EEG (electro-encephalogram)
5) Nurse or paramedic - physician -- request for advice -- reporting on condition of patient -- remote EKG, EEG, etc.
6) Physician - computer -- diagnostic aids -- patient records -- pharmaceuticals, etc.

The questions to be solved are whether and how the provisions of such services, or their improvement, could contribute to more effective health care, more economical care, or more widely available care.

One major problem is that of expanding the effective range of individual physicians' services -- both numerically and geographically. There is much discussion today about an expanded use of nurses and paramedical personnel, working under physician supervision, in order to bring health services to more people. The decision to go this route, and the devising of a suitable organizational structure to control it, is the job of the medical profession. However, if it is planned to have the initial patient contact in store-front clinics, satellite clinics, nursing homes, or factory first-aid centers staffed by physician assistants, then there must be easily available physician back-up. This might be provided by a system of "telemedicine." Telemedicine may be defined as any system which permits a physician to provide medical care at a distance. In general, telemedicine systems incorporate paramedical personnel and some form of telecommunications. Early forms of telemedicine utilized narrow-band communication channels. Two-way radio has served military units, ships at sea, missionaries, public health nurses, and many others as a means of obtaining medical advice. Telephone communication is also commonly used; for example, in Estancia, New Mexico this form of communication currently forms the basis for supporting a nurse practitioner who delivers primary medical care. More recently, wide-band communications have been employed in medical care systems. It has been demonstrated that effective doctor-patient relationships may be established via interactive two-way television. Furthermore, it has been shown that a remote physician may obtain an adequate medical history, perform a significant portion of the physical examination, read EKG's, examine X-rays, etc., using a video link. Psychiatric interviews have been conducted with considerable success using this media.

Since each of these communication channels comes at a real cost, whose level is roughly proportional to the complexity of the service, it is clear that a careful assessment must be made of the relative utility of, for example, two-way video versus the telephone. There will seldom be unique answers and important special cases will probably appear where expensive and elaborate communication equipment will be justified. Since many experimental programs for new health-care systems are now being planned, we believe

it is important that funds for a variety of experiments with telecommunications services be made available to discover the most effective ways of using them.

For many services, there seems no reason to supplant the telephone. It can furnish communication by voice, teletype, facsimile, and analog or digital data, depending only upon terminal equipment. For moderate resolution video (1 MHz) the telephone network and videophone will soon be available. This may be quite adequate for face-to-face consultations but may be inadequate for diagnostic purposes. If so, we must go to microwave or laser relay links or to wide-band, point-to-point cables (such as network number 3 described on page 31).

The mode of choice is almost entirely a matter of local topography and economics. It is the writers' belief that it will be more expensive to piggy-back medical services on cable TV networks than to install separate cables, if privacy is to be provided to the degree believed necessary.

The principal reasons are that the relatively more complex services needed for two-way video by a small number of locations would place an unreasonable economic burden on the majority of the users who need simpler systems; and further, that privacy of medical consultations would be compromised. One can make messages more secure by scrambling, but only at a cost in equipment. This extra cost must be compared with the costs of private circuits.

Although the sharing of cables with the broadcast oriented cable television operators is likely to be more expensive for medical services than separate cables, a potentially important cost saving option may be made available by the growth and development of cable television systems. A very substantial portion of the costs for cable communication is due to high installation expenses, the cable itself is relatively inexpensive. If the cable television operator were provided the appropriate incentives (for example, via the franchise agreements) it would be possible to link several points within a community with broadband cable at the same time that the cable TV network was being installed. By installing and sharing underground communications ducts or pole space, points of the health care system could be joined for wide band communications services at relatively low costs.

The use of the computer in the health care system is growing; but there are still many unanswered questions about its legitimate place(s) in the system. Record keeping within a hospital complex appears to be a firmly established role. Computer-aided diagnosis in busy outpatient clinics may soon reach a similar degree of acceptance. On the other hand, the use of the computer in multiphasic screening is still controversial, simply because the concept of screening is still in dispute. Centralized maintenance of patient histories in computer data banks, with remote access in physician's offices, etc. appears to offer important benefits; but the system safeguards to insure privacy, and to control the right to add to or delete from the records have a long way to go before they can be considered solved.

In summary, it appears that there are many possible ways in which the broad area of telecommunications technology might be utilized in medical care systems. Much remains to be discovered, however, about the potentialities of such systems, and their socioeconomic impact. For this reason a variety of programs should be funded to discover how best, and where, to use telecommunications as adjuncts to medical care systems. Several specific projects are outlined below.

TELEMEDICINE SYSTEM PARAMETRIC STUDY
(Telecommunications and Medical Services)

I. Objectives

To develop a systems analysis approach to the study of telemedicine, including models incorporating significant medical, engineering, and socio-economic factors.

To study the potential of telemedicine systems as a function of such variables as skill of physician-assistant, bandwidth of communication channel, system operating policy, etc.

To determine optimal distribution of diagnostic and therapeutic equipment within the system.

To determine the appropriate degree of allocation of skills and responsibilities to physician-assistants.

To develop protocols* for patient work-up** which contain built-in (possibly automated) quality controls.

To develop specifications for training programs for telemedicine physician-assistants.

II. Project Outline

A. Nature and Scope

A telemedicine system consists, in general, of the resource physician (or physician group) and one or more communication links to remote clinics staffed by physician-assistants. Transportation links are also required between remote clinics and resource physicians. The level of medical care deliverable by each link of the system would be expected to be a function of several system parameters including (a) the skill level of the physician-assistant (PA) and the amount of responsibility delegated to him, (b) the diagnostic and therapeutic capacity of the remote clinic, (c) the bandwidth of the communication channel, (d) the expertise of the resource physician, (e) system operating

*protocol - planned order of procedure.
**work-up - examination and testing preliminary to making a diagnosis and recommending treatment.

policy, etc. (see Figure 1). The above factors are not independent. For example, a given level of care might equally well be provided by a highly competent PA using a narrowband communication link and and a less sophisticated PA using a more elaborate communication link. Furthermore, each degree of increased sophistication brings a related increase in cost.

In planning for area-wide medical care systems utilizing telemedicine, it is essential to understand the various trade-offs regarding the above-mentioned variables. This project proposes a parametric study of telemedicine systems to obtain the necessary data.

The project would be conducted in two phases.

Phase I would be a detailed planning study prior to any actual implementation of a system. During this phase, various telemedicine systems should be modeled. Operational definitions and measures of system performance, effectiveness, and costs must be determined to permit comparison among systems, and to provide a rational basis on which to collect data from actual field trials. The study would necessarily bring together all presently available data relating to individual system components and their expected strengths and limitations. For example, considerable experience has been accumulated over the past several years regarding the possible role of a variety of classes of "physician-assistants." A careful evaluation of their skill levels and assessment of the degree of responsibility which they might assume is crucial to the study. Some data is also available relating to the characteristics of various classes of communication channels as used in delivery of medical services.

The study should attempt to determine the optimal configuration of the remote clinics with regard to diagnostic and therapeutic equipment. For example, should each clinic be equipped with X-ray? centrifuges for hematocrits? urinalysis equipment? EKG machine? etc. It becomes clear that the answers to many of these questions will be a function of the input sample, the specific locale where the system is to be deployed, total system operating policy, etc. The economics and psychological aspects of this type system must also be carefully examined.

In order to keep the Phase I study "down-to-earth," it is recommended that a specific area be selected for eventual trial of a telemedicine system, and that real-life data be gathered from that area in predicting system performance.

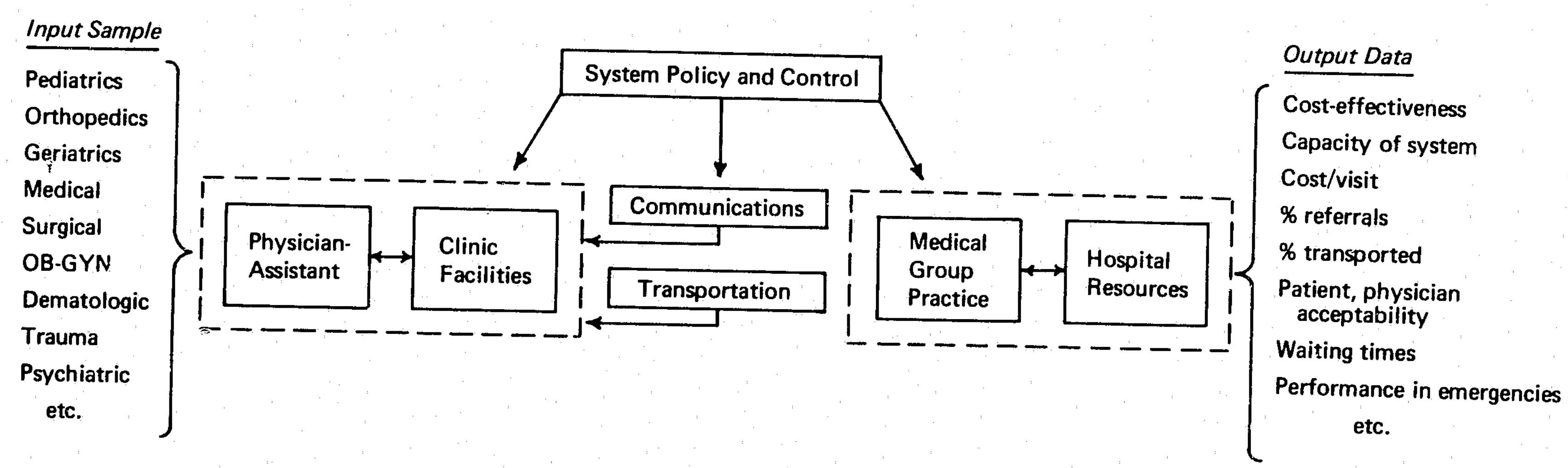

Input Sample
Pediatrics
Orthopedics
Geriatrics
Medical
Surgical
OB-GYN
Dematologic
Trauma
Psychiatric
etc.
System Policy and Control
Physician-Assistant
Clinic Facilities
Communications
Transportation
Medical Group Practice
Hospital Resources
Output Data
Cost-effectiveness
Capacity of system
Cost/visit
% referrals
% transported
Patient, physician acceptability
Waiting times
Performance in emergencies
etc.

Figure 1

Furthermore, it would be quite important that individuals from the target area (both from the medical community and from the non-medical potential users) be included in the study from its earliest phases.

Phase II of the proposed project would be to implement one or more telemedicine links in situations which would provide a representative distribution of inputs to the system. "Representative" implies that the patients' ages, presenting complaints, stage of illnesses, etc. be typical of the region for which the system is being planned. Thus, one would expect medical, pediatric, obstetrical, surgical, geriatric, psychiatric, etc. diseases of varying degrees of severity from simple routine problems to acute emergencies.

There are several conceivable ways for establishing such an experimental link including (a) operating within a large hospital outpatient department with the PA in one room and the MD in another; (b) setting up a link from a hospital to an urban or suburban satellite clinic where the physicians would be at the hospital and the PA at the clinic; (c) providing medical care via telemedicine to a community (suburban, rural) without other forms of adequate medical care; i.e., provide the function of a family doctor in a needy community. Of these three alternatives, both (a) and (b) are somewhat artificial, while (c) has the advantage of filling a real need -- hence, minimizing patient and physician resistance. If more than one telemedicine link configuration were to be evaluated, it would seem optimal to use the same physician group with several links to different but similar communities. This approach is very similar to Project B: Rural Medical Care System.

During operation of the deployed system, data would be collected in accordance with the framework developed in Phase I. Protocols for patient work-ups should be developed, perhaps utilizing automation. The incorporation of machine data storage and processing would seem quite appropriate. Furthermore, automation could be used to provide quality control checks to assume completeness of patient work-up, physician consultation whenever necessary, etc.

B. <u>Project Implementation</u>

1) Milestones

a) Phase I -- Systems Analysis and Model Development. Theoretical consideration of telemedicine systems. Model development permitting operational measurement

of system performance, and comparison of different system configurations. Determination of suitable input samples, based on actual surveys of disease incidence in target area.

b) Phase II -- Experimental System Implementation--Construction and implementaion of test system(s). Accumulation of data on system function versus bandwidth, and study of other decision can be made regarding possible expanded use of tele-medicine to provide area-wide medical care.

2) Implementing Organizations

This study will require an implementing organization capable of assembling an interdisciplinary team of workers including communications and instrumentation engineers, systems analysts, managers, physicians, paramedical personnel, etc. The second phase of the program also requires involvement in medical care facilities. The project seems quite appropriate for a university to undertake, particularly one with both engineering and medical expertise, provided it can assemble and properly manage such a task-oriented team. Certain government agencies, such as the Public Health Service, Indian Health Service, or military agencies could perform this type of study, and would have applications for telemedicine. Certain industrial organizations could also conduct the study by assembling the appropriate interdisciplinary teams and establishing working relationships with the medical community.

3) Time

Phase I - Approximately 1 year.
Phase II - Approximately 2 to 5 years.

4) Location

Location is not critical.

5) Evaluation Process

Discussed above.

6) Costs

Detailed cost breakdowns have not been made but gross estimates might be:

Phase I: $300,000 to $400,000
Phase II: Difficult to estimate because of various possible system sizes and configurations, unknown amount of income generated by collections, etc.

III. Related Programs

Telediagnosis } Massachusetts General Hospital, Boston
Teleconsultation }

Lowndes County, Alabama Health Care Project (OEO)

Dartmouth-Claremont Link

Royal Flying Doctor Service, Australia

IV. Growth Potentials

Results from this study project would form the basis for planning area-wide medical care systems which could potentially serve rural communities, Indian Reservations, mining camps, developing countries, remote astronauts, etc.

Health

RURAL MEDICAL CARE SYSTEM
(Telecommunications and Medical Services)

I. Objective

To improve the quality and availability of medical care to rural areas.

To study the role of telecommunications in catalyzing more effective use of physician assistants.

II. Project Outline

A. Nature and Scope

A major problem in American medicine today is how to provide uniformly excellent medical care to all citizens. One group of Americans who often are left with sub-standard care are those who live in rural areas -- particularly poor rural areas. Many small communities find it impossible to attract and retain physicians. Their nearest source of medical care may be many miles away and even then may be an overworked practitioner.

The basic problem is one of a limitation of a crucial resource, namely physician time. In rural areas this limitation appears to be due in part to an overall scarcity of practicing physicians, and in part to socio-economic and cultural factors which cause uneven distribution of physicians. Rural areas have the additional problem that there are many small towns and communities separated by considerable distances. Often the individual community is too small to support even a single physician, not to mention a group which might include specialists.

It would appear that the solution to the medical care problem for rural areas will include:

1) Regionalization of medical care, such that one resource of medical expertise is distributed to many isolated communities in an area.

2) Expanding the effectiveness of a given physician both in terms of his maximum patient load and his geographical range -- presumably through allocation of responsibility to physician assistants; substitution of telecommunication for transportation; and use of modern biomedical technology including computers.

This project proposes to establish a demonstration system for rural medical care incorporating telemedicine techniques. In broad terms, the proposed system would consist of a centrally located group practice of medical and surgical specialists and a number of outlying satellite clinics. The physicians would remain for the most part at the headquarters for the system which would be located in immediate proximity to a well-equipped hospital in a moderate-sized, centrally located town or city. The satellite clinics would be located in individual outlying communities out to a radius of 50 - 100 miles. Each clinic would be staffed by one or more specially trained physician-assistants, and would be equipped with certain clinical laboratory facilities. The clinics would be coupled to the resource physicians by appropriate telecommunications channels. The details of the equipment to be located at the clinics, the skills and responsibilities of the physician-assistant, the necessary communications bandwidth, etc. would be determined on the basis of the System Parametric Study described above.

Patients entering the system would be seen by the physician-assistant. Initial evaluation would be performed by him, and would in general consist of a medical history, a physical examination, and appropriate laboratory tests. The PA would then decide whether or not a physician consultation was needed; and if so, through what mechanism. In general, three options would be available: (a) a teleconsultation (b) travel by the patient to see the physician, or (c) travel by the physician to the patient. The first option would presumably be available always. The second option would be necessary in cases requiring immediate and complex emergency care, or in cases requiring more sophisticated medical work-up than is possible via telemedicine. The third option assumes that the physicians would make regular "rounds" of the outlying communities, holding clinics on a periodic basis. It is not clear that this activity would be maintained in all cases, but it might serve to increase patient acceptability of the system, and to improve the physicians' familiarity with the communities.

It seems likely that a majority of patients could receive their care without traveling to the physician. Some could be handled completely by the PA. In many other cases, final diagnosis and treatment could be made by the remote physician based on the findings of the PA, and supplemented, if necessary, by his own remote diagnostic maneuvers. In very complex or

CONTINUED

1 OF 3

emergency situations, the PA could have immediate access to the appropriate specialist who could obtain sufficient information through the communication system to make informed, rational decisions regarding initial patient management and follow-on treatment, including transportation (see Figure 2).

Obviously an efficient transportation network must be an integral part of such a medical care system. There is also a place for certain types of automation in such applications as centralized patient record system, automated patient histories (esp. for chronic disease follow-up), quality control (in conjunction with record system), and semi-automated diagnostic systems to support the PA.

B. Project Implementation Details

1) Milestones

a) Phase I. System Definition

Formation of planning team which should include physicians of several specialties (internal medicine, general surgery, pediatrics, etc.), one or more physician-assistants, communications engineer, systems planner, financial manager, etc. Selection of appropriate area for deployment of system. The best test-bed for the system would be an area which has virtually no pre-existing medical care, thus minimizing chances for community and professional opposition. Community representatives and local physicians, if any, must be involved in the planning phase.

Planning should include development of a suitable model for the system, including the establishment of quantitative performance criteria on which to base system evaluation. Ideally, much of the necessary information for planning would be obtained from the Telemedicine System Parametric Study described above. In addition, planners must develop a fiscal program to cover operating costs of the system possibly with a prepaid plan of some sort. An important criterion for success of this project is its ability to be self-supporting. Finally, planners must work out legal and licensing problems with regard to the duties and responsibilities of the PA's.

b) Phase II. System Deployment

Recruit and train necessary personnel. Construct and install hardware, clinic facilities, communications equipment. Deployment may be in stepwise fashion beginning with only one community.

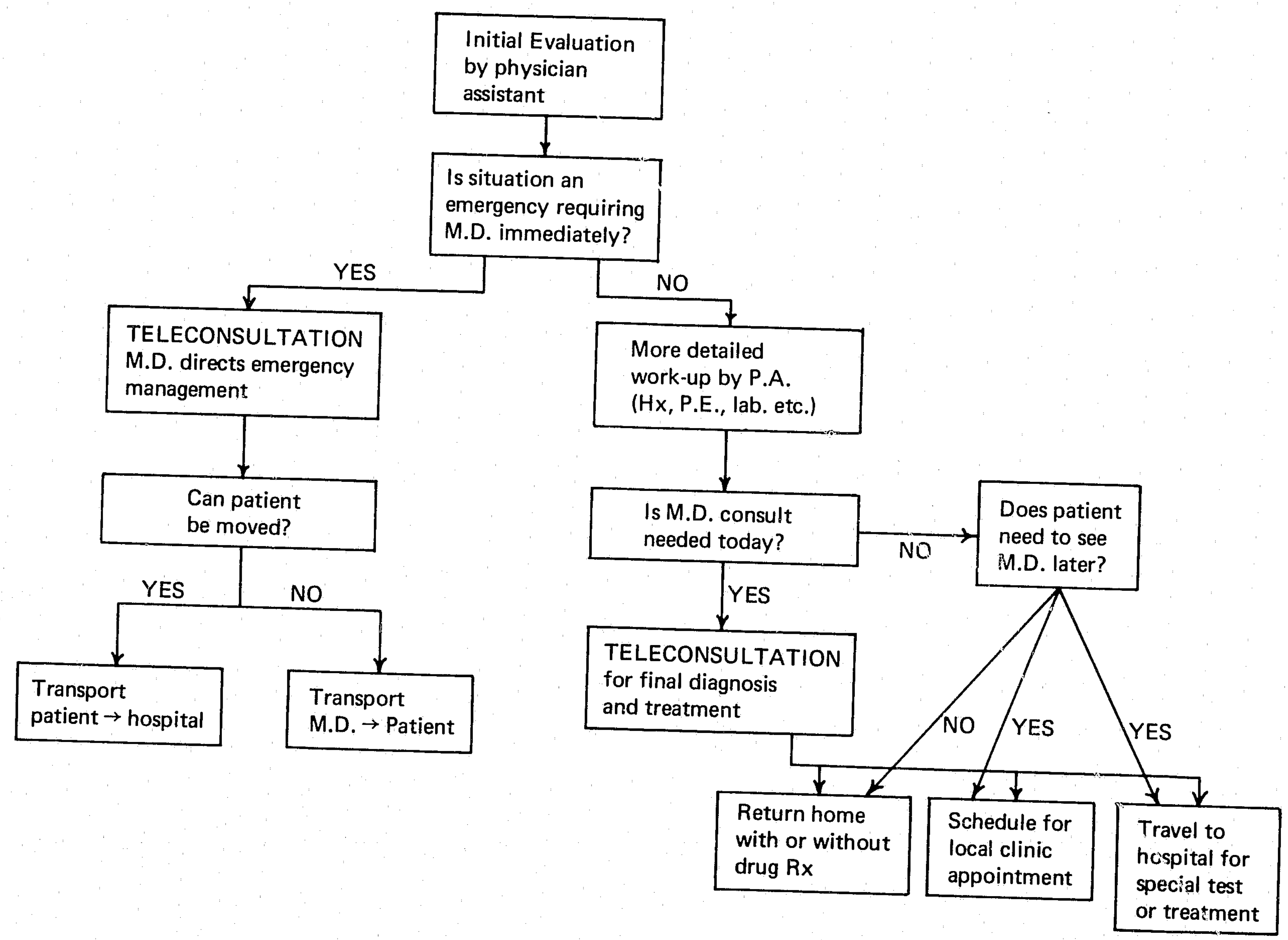

Initial Evaluation by physician assistant
Is situation an emergency requiring M.D. immediately?
YES
NO
TELECONSULTATION M.D. directs emergency management
More detailed work-up by P.A. (Hx, P.E., lab. etc.)
Can patient be moved?
Is M.D. consult needed today?
NO
Does patient need to see M.D. later?
YES
NO
YES
TELECONSULTATION for final diagnosis and treatment
Transport patient → hospital
Transport M.D. → Patient
NO
YES
YES
Return home with or without drug Rx
Schedule for local clinic appointment
Travel to hospital for special test or treatment

Figure 2

2) Implementing Organization

There are several possible implementing organizations. University groups, perhaps centered around a medical school could implement this project. Schools located in relatively rural regions might have maximum motivation. The USPHS could act as an implementing organization because of its involvement in Indian health services. Reservations, such as the Navaho Reservation, could likely benefit from a telemedicine system. Private medical groups might also implement such a program provided they could obtain sufficient technical back-up.

3) Time

a) Phase I - 6 months (assuming results of Telemedicine System Capability Study were available).

b) Phase II - 3-5 years.

4) Location

Any rural area in which the present medical care is inadequate.

5) Evaluation Process

6) Cost

Obviously, a function of the size of the proposed system. However, the operation of the system should eventually be self-supporting, hence the initial start-up costs could be provided on a loan basis. They might run in the order of $500,000.

NURSING HOME MEDICAL CARE PROJECT
(Telecommunications and Medical Services)

I. Objectives

A. To improve the quality and availability of medical care to patients in nursing homes.

B. To decrease costs of geriatric care by reducing the frequency of hospital visits and admissions, and by early treatment of disease.

C. To demonstrate methods for improving the utilization of physicians through more effective use of paramedical personnel together with appropriate communications systems.

D. To determine the capabilities and limitations of such systems for the delivery of this form of remote medical care.

II. Project Outline

A. Nature and Scope

One group of urban citizens who often receive suboptimal medical care are the elderly -- particularly those who are confined to nursing homes. These individuals are usually poor, and typically suffer from one or more chronic diseases. Nursing homes frequently find it difficult to obtain adequate physician coverage for their patients. In urban areas, particularly the less affluent sections, there are relatively few practicing physicians, and those few are extremely busy. They tend to be reluctant to visit nursing home patients because of a lack of time and because of their difficulties in collecting fees from many welfare departments. Some nursing home patients, therefore, receive virtually no regular follow-up care by a physician. Other patients are followed in hospital outpatient clinics to which they must be periodically transported at considerable discomfort and cost ($70-$90 round trip).

This project proposes to establish a hospital-based system to provide continuing follow-up care to patients discharged from that particular hospital to a variety of different nursing homes. In effect, the hospital's medical

service would assume responsibility for the on-going care of these patients through its out-patient department -- but, instead of transporting patients to the hospital clinic, medical care would be brought to the patient in the nursing home. The objectives of the system would be to:

1) Provide regular follow-up examinations for patients with chronic diseases. These examinations would be the equivalent of an outpatient clinic visit, and would assure the patient of continuity of care.

2) Provide appropriate preventive care, when feasible, to all patients being followed (influenza immunization for example).

3) Provide for prompt recognition and treatment of new treatable illnesses, such as infectious disease, etc.

4) Provide training for nursing home staff.

The system would consist of one or more specially trained nurse practitioners who would make regular visits to a group of selected nursing homes. The nurses would work under the supervision of a hospital-based physician, communicating with him when necessary via telephone. The duties of the nurse practitioner are listed in Figure 3, and include the ability to perform a modest number of simple laboratory tests, to obtain medical histories, and to conduct physical examinations. For patients with known chronic diseases, standard protocols may be established regarding what examinations should be made. On the basis of the nurse's knowledge of the patient and her observations, she must make certain decisions which are outlined in Figure 4. Essentially she must decide whether a physician consultation is needed or not. If the situation demands a consultation, this would be obtained via telephone. Medical observations, historical data, and laboratory results would be transmitted verbally. EKG data could be sent and reproduced via telephone using commercially available instrumentation. Other audio information such as heart and breath sounds could also be sent via telephone. The nurse/doctor team would then make decisions regarding the appropriate action to be taken.

Another important function of the nurse practitioner would be to teach the nursing home staff, particularly in

Figure 3

<u>Duties of the Nurse Practitioner</u>

1) Obtain medical history, particularly interval history.

2) Perform appropriate physical examination.

3) Obtain electrocardiogram.

4) Perform certain laboratory tests including:

   a) Hematocrit/Hemoglobin

   b) White blood count, (differential)

   c) Routine urinalysis

   d) Serum glucose, BUN, and other calorimetric tests

   e) Stool occult blood

   f) Obtain specimens for culture

   g) Obtain blood specimens for later analysis

5) Administer IV fluids.

6) Insert/change urinary catheters.

7) Perform routine medical/surgical nursing techniques and be able to teach skills to nursing home personnel if necessary.

- - -

the areas of medical observation and nursing technique. As the level of expertise of the nursing home staff increased, it would become possible to rely more heavily on them to make the appropriate medical evaluations. At this point it would be possible to proceed to a follow-on system which would incorporate more automation.

Decision Matrix

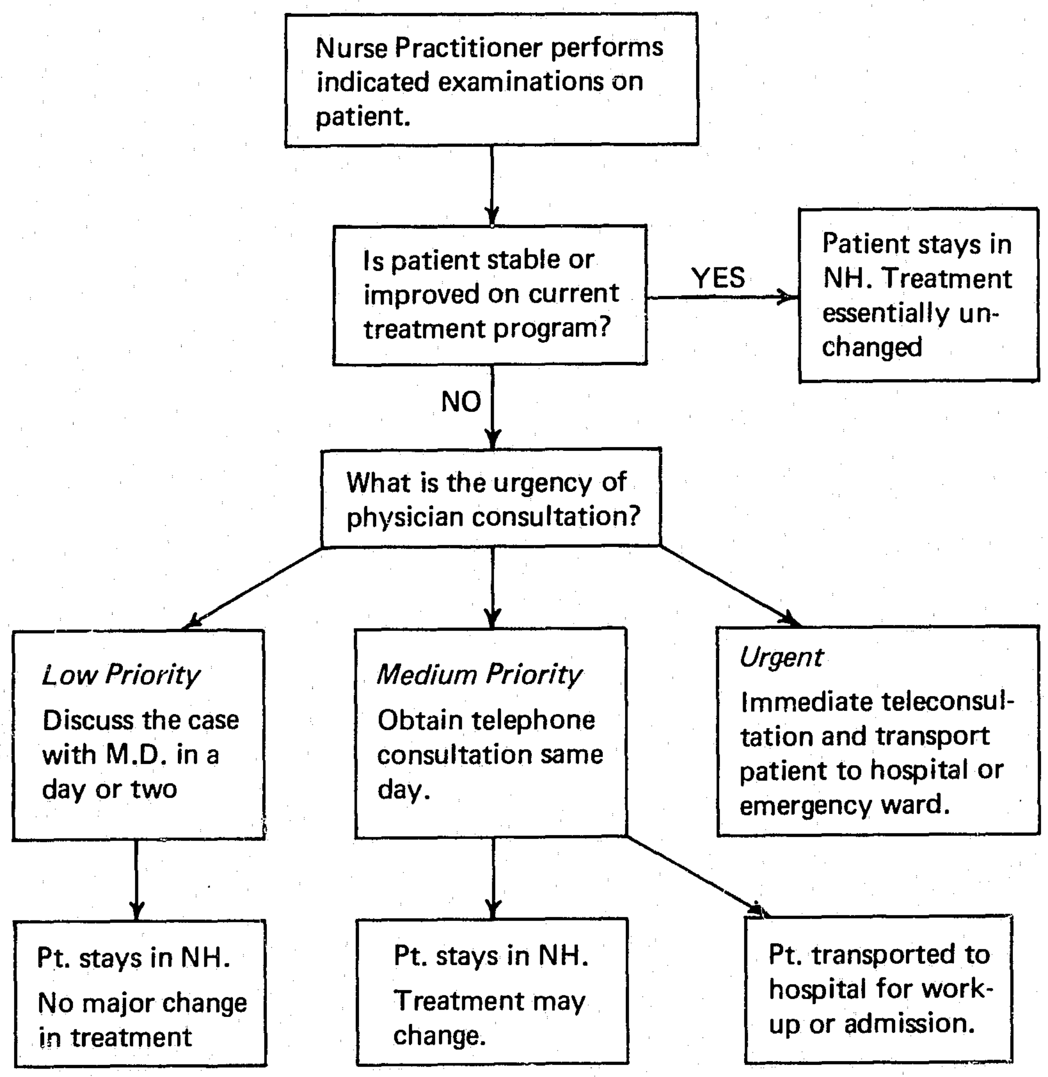


Figure 4

As a follow-on project it is proposed to establish fixed protocols for the periodic evaluation of patients with certain chronic diseases (i.e., hypertension, heart failure, diabetes, etc.). Such protocols would pose a series of questions in branching-type sequences, and request certain medical data (pulse, B.P., etc.) and laboratory tests. On the basis of the observations and the individual limits set for the particular patient involved, a decision is made whether or not to request a physician consultation. Work in developing such protocols is currently in progress under the direction of Dr. Herbert Sherman at Lincoln Laboratory and Beth Israel Hospital in Boston. Individual protocols could be generated by a hospital-based computer, and presented on a large number of remote terminals. The operator entering data at the remote terminal could be a nursing home attendant, after sufficient training by the nurse practitioner. Communication between the hospital's computer and the various nursing homes could be via broadband communication network cables. TV terminals of the type proposed elsewhere in this report which incorporate "frame-grabbers" and a narrow band upstream feature would be quite adequate for this application.

By time-sharing the downstream channel several hospitals could use the system. Alternatively, several hospitals might collaborate and use a single point of origin for the protocol administration, and distribute the results appropriately (see figure 5).

B. Project Implementation

1) Milestones

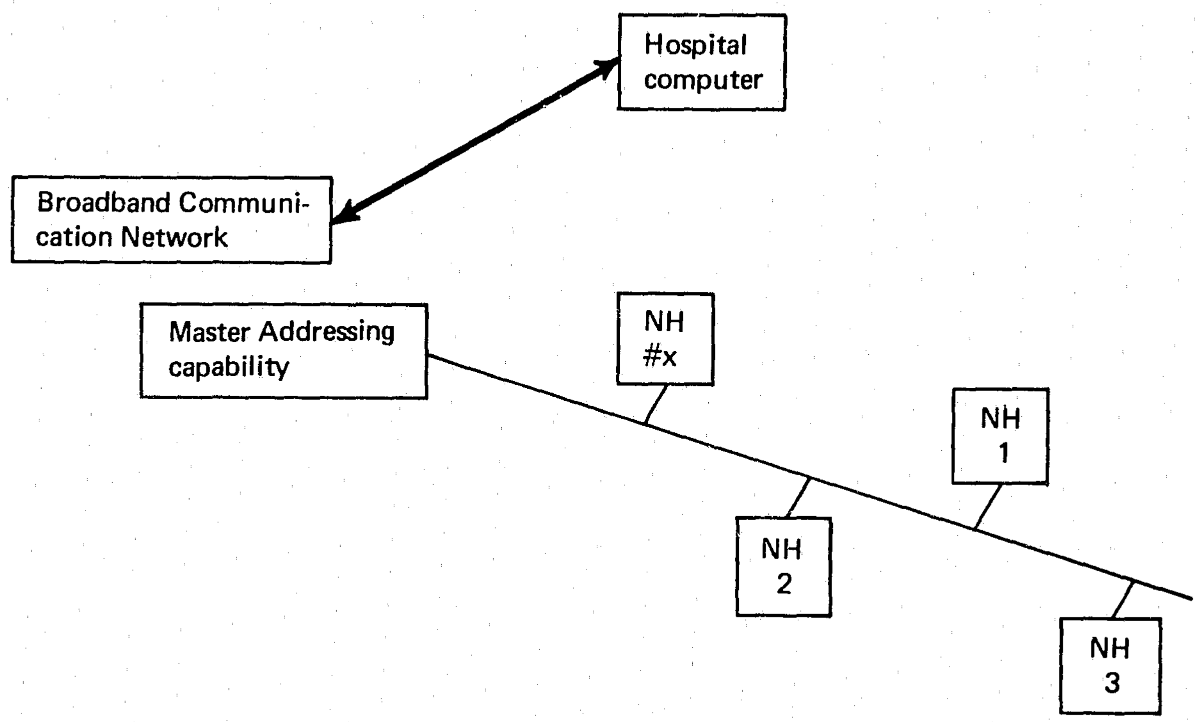
a) Phase I: Project definition.

Identification of appropriate nursing homes for inclusion in the project, and a similar group to serve as controls. Identification of methods to be used in evaluating effectiveness or quality of medical care, and costs of care. Definition of technical details including necessary laboratory equipment, EKG telemetry equipment, patient record systems, etc. Definition of personnel requirements, including design of training programs. Development of detailed organizational framework for integration of system into particular hospital structure.

b) Phase II: Personnel Training and Equipment Fabrication

Nurse practitioner(s) recruited and trained in needed skills defined in phase I. Purchase and assembly of portable laboratory equipment and supplies. Evaluation

Figure 5



Patient ID: Joe Doe

NH #2 access code: xxxxx — "Frame grabber" activated with this number.

<u>Heart Failure Protocol</u>

Question N:
Has the patient experienced swelling of ankles?

NH#3 Access Code xxxxx

Patient: Alice Smith

<u>Diabetes Protocol</u>

Question M:
Is the patient currently taking regular insulin?

of functional effectiveness of nurse laboratory equipment in supervised trials in hospital outpatient department. When satisfactory performance levels are demonstrated, proceed to phase III.

c) Phase III: <u>Implementation</u>

Begin follow-up of patients in nursing homes as outlined above. Collect data from both study and control groups during this period, in accordance with criteria established in phase I.

d) Phase IV:

Development of semi-automated patient follow-up system using computer-administered evaluation protocols for patients with chronic diseases. Although this system might eventually utilize a broadband communications network system and TV-type interactive terminals, initially it would use narrow-band communication channels and slower interactive terminals.

2) Implementing Organizations

One or more pilot programs could be established in different sections of the country. The best implementing organization would be a university-affiliated municipal or county teaching hospital. The prime responsibility could be with either the medical school administering the teaching program or the hospital itself. In either case, both the university and the hospital would have to cooperate closely.

3) Time

Estimated time requirements for phases I, II, III are:

Phase I - 3-4 months.
Phase II - 3-4 months.
Phases I and II may overlap somewhat.

Phase III - 1 year minimum.

Phase IV is really a follow-on project which would take on the order of 2 years to implement.

4) Location

Any urban area with a suitable implementing organization. Phase IV might be best done in a city with existing BCN systems.

5) Evaluation Process

Since the stated objective of the program is to improve the quality of medical care to a selected population, it is of utmost importance to determine an acceptable measure of quality of care. A specific list of measurable parameters must be established in the first phase of the program, i.e., number of hospitalizations, length of hospital stays, mortality, incidence of complications of chronic diseases, etc.) When the system is deployed these variables must be measured in both control and study groups. Care must be taken to measure the control group in such a way as to avoid affecting its operation. Similarly, criteria for determining true costs of alternative systems of medical care must be established at the outset of the study, and then data collected from both groups.

6) Cost

The estimated costs for initial year of the program would be $50,000/$60,000, assuming two nurse practitioners. Major cost items would be personnel salaries. After the first year or two, the system should be self-supporting on the basis of collections for patients' visits.

The more automated project outlined in Phase IV is of a completely different order of magnitude regarding cost. This phase requires a well established hospital information system which would be a source of patient data. Project costs would have to include the cost of remote access to the computer, but not costs of the basic hospital computer. Considering a system using three nursing homes, a rough guess at costs might be as follows:

Modification of access to hospital computer	$ 10,000
Hospital terminal installation hardware and software	250,000
Three nursing home terminals	30,000
Leasing telecommunications	20,000
Operating expenses at three nursing homes and one hospital for one year.	80,000
Two year total	$390,000

Assuming a five-year life for the system at a follow-on annual cost of $100,000 per year for four years, the total cost would be in the order of $800,000. As this would cover over 5,000 nursing home days (three homes), we are talking of a cost of $160 per nursing home day or the savings of two ambulance rides per day per home at $70-90/round trip. Thus, the costs of such a system are not at all unreasonable. Furthermore, collections would be expected to offset most, if not all, of the system costs.

III. Growth Potential

If the pilot study successfully demonstrates improved quality of care at reduced costs for nursing home patients, and further, if the system can be demonstrated to be self-supporting, then it would probably be duplicated at many urban medical centers with little direct federal support. The impact on society could be considerable savings in medical expenses for geriatric care. If widely implemented, the program would place heavy demands on nurse practitioners the physician assistants. This would probably necessitate the establishment of more training programs for this type of professional.

* * *

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Subpanel on Environment and Health: Robert A. Henle (chairman), William H. Pickering, Louis D. Smullin, Roger Mark (consultant), and Stanley A. Garlick (staff).

AIR POLLUTION MONITORING INSTRUMENTATION

I. Objectives

A. To demonstrate the practical applications of infrared laser technology to the measurement of air pollution.

B. To develop instruments suitable for field use.

II. Background and Scope

The sources and effects of environmental pollution are only too well known. Impure air, water, and soil are the most obvious elements of the pollution problem. Add to these the noise, congestion, structural dilapidation, and general filth of our cities and one sees a more complete picture of the pollution that has degraded urban life.

Beyond the direct physical impact of pollution are its side effects. The abandonment of the central city and resulting urban sprawl are at least in part caused by the increasingly hostile environment of most metropolitan areas. The advantages of living in the city are being outweighed by its dangers and discomforts.

There appear to be two approaches to the control of pollution. One is to attack the symptom; that is, to find ways of removing pollutants from the environment. The other is to regulate the source, either by stopping the activity that produces pollution or finding new techniques of conducting the desired activity that do not pollute. Both approaches will work. The question becomes one of controlling without undesirable side effects. Thus we are probably unwilling to stop using electricity to control its contribution to air pollution by way of power generating plants.

The role of technology in controlling pollution is critical. To the extent that technologists can develop alternatives to pollution-generating activities and new methods for removing pollutants from the environment can we enjoy the benefits of these activities without the serious drawbacks of urban contamination. Where technology fails, legislation must act to curtail polluting operations, and the associated benefits must be sacrificed.

Telecommunications technology stands to play an important part in the control of pollution: indirectly, to the extent that efficient, effective communications can replace or eliminate the necessity for polluting activities; and more directly by providing acquisition, collection, and analysis of data for use by pollution researchers and control authorities.

Recent legislation has added a legal impetus to the necessity for gathering environmental quality information. In order to assure compliance with established standards, control authorities must have accurate data on both ambient levels of pollution concentration and emission levels at individual sources. Monitoring systems with sensing stations capable of measuring many pollutants and reporting data to a central location will fulfill the needs for surveillance of the ambient environment. For the policing of individual pollution sources such as industrial plants and automobiles, both fixed and mobile instruments will be used to measure concentration of specific pollutants (e.g., SO_2 from a power generating plant).

Monitoring systems can definitely benefit from the use of telecommunications facilities for data collection from individual sensing stations. However, the data rates required for this are usually low and dictate only narrow band circuits (e.g., a telephone line). Thus the development of monitoring systems is not constrained by needs for advanced communications techniques.

The availability of reliable, economical sensors is a critical factor in the development of efficient monitoring systems. Instrumentation now in use is generally of a laboratory type, usually involving wet chemistry and requiring skilled personnel for operation and maintenance. Furthermore, there is presently no instrument available which would allow control authorities to make quick spot checks of emissions from individual sources. It is suggested here that such devices are necessary for the effective enforcement of legislation.

Thus, two types of instruments are needed: (1) multipollutant sensors which will operate reliably at remote unattended sites and transmit their data to a central location, and (2) instruments designed for mobile use to examine individual pollution sources.

One of the more promising physical principles for air pollution measurements is the absorption and scattering of

infrared radiation by the atmosphere. Each molecular species has a specific infrared spectral signature, and therefore spectral measurements, in principle, can identify the type and concentration of various pollutants. This can be done by observing the absorption of radiation of known wavelength due to passage through a sample of atmosphere. Stack gas can be identified by observing the scattered radiation when the plume is illuminated at a prescribed wavelength.

Measurements can also be made of the passive emission spectra from atmospheric pollutants.

Each of the three techniques -- emission, scattering and absorption -- requires a reliable and stable infrared source of very narrow bandwidth and a sensitive detector. Laser technology can provide the answer. Two possibilities exist, either a heterodyne method using frequencies generated by, for example, a CO_2 laser, which are very close to the desired frequency, or the use of a tunable laser which can be placed on the precise frequency desired. Experimental work with each method is in progress, but in order to meet requirements of the Clean Air Act of 1970, the work should be accelerated; otherwise it is doubtful that fieldworthy instruments will be available in time.

III. Implementation Details

A. Programs

This project should be an extension of work currently in progress at the Environmental Protection Agency. Contracts now active cover much of the field; but it is necessary that work be focused on the two objectives identified above. The project can then be separated into two phases:

1) Laboratory Phase:

The spectra of various known pollutants need to be explored in the laboratory using narrow band systems. Either tunable lasers or heterodyne systems could be used. Mixtures of gases similar to the normal atmosphere should be examined to determine regions of the spectrum where unequivocal identifications are possible. Experiments should then be conducted in the atmosphere using laboratory instrumentation.

2) Instrument Development Phase

Following the laboratory work, efforts should be directed toward the attainment of field-worthy instruments. Instruments should be developed as multi-pollutant sensors and made available in two forms: (1) an absorption instrument suitable for both point and long-path ambient measurements, and (2) an instrument designed for mobile use in examining air pollution source emissions.

B. Time

Program 1, the laboratory work, should be completed by the end of 1972. Program 2, which would produce prototype instruments, should be concluded one year later at the end of 1973.

C. Costs

For approximation purposes only the following cost estimates are given:

Laboratory Phase - about $500,000 for four researchers and their support.

Instrument Development Phase - about $1 million for the design and production of two operational prototypes.

D. Related Programs

It is important to point out that the development of pollution sensing devices for monitoring of stationary sources has taken at least two directions. On one hand, instruments are being designed for installation and continuing operation at the source itself (for example, devices to be installed inside a smoke stack to provide data on pollutants passing from that stack). Such devices would be operated and maintained by the plant or factory.

The second approach to source monitoring is the one suggested here and recommended for more intensive federal support. Long path sensors would be developed primarily for use by the control authorities to assure compliance with regulations. Most important, spot checks of potential offenders would be possible.

Both approaches to source monitoring are important, but if pollution regulation offenders are to be identified, it is the long path instrument which will be most effective.

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Subpanel on Environment and Health: Robert A. Henle (chairman), William H. Pickering, Louis D. Smullin, and Stanley A. Garlick (staff).

Transportation

Introduction

There are two major categories of urban transportation systems -- personal vehicle systems, such as taxicabs and private cars; and mass transit systems, such as buses and rapid transit rail systems. Both classes of transportation are used for radial travel, to and from the city center to outlying residential areas and for transverse travel within the city.

Both categories of urban transportation are necessary, but ideally should complement rather than compete with each other. For regular travel between points on a fixed route, from the circumference to the center, or from point to point within the city, mass transportation usually provides the most efficient mode of transportation. For other types of travel by persons, or for the handling of freight and merchandise, personal vehicles, i.e., cars, taxis, and trucks, are often most efficient.

With the exception of rapid transit systems on their own rights of way, all urban transportation, both personal vehicles and mass transit, use the streets and highways.

In view of the present congestion of city streets and highways, which in many cities has been increasing annually and threatens complete strangulation in our major cities, there is need for improvement of urban transportation.

Telecommunications can aid the improvement of city transportation by automating and optimizing traffic flow on streets and expressways, and making effective use of hybrid vehicles that can travel both on guided paths or on streets.

However, the Committee is aware of the intensive research efforts on the optimization of traffic flow on city streets, urban traffic corridors, and freeway operations.

Improvement in the efficiency of mass transit systems can be made by means of automatic monitoring of vehicle location, operational conditions, and passenger status coupled with computerized dispatch and control. Telecommunications would be an essential tool in implementing such systems. There are a number of projects currently under way in these fields.

In the case of buses, another means of improvement in efficiency is the creation of exclusive bus lanes on heavily

travelled highways, during the heavy traffic periods of the day. This is already being tested; see references 1 through 5. Good communications are essential to the efficient use of these bus lanes, but no innovations are required -- merely the application of existing techniques.

Improvements in the efficiency of operation of mass transportation, such as decreasing delays during trips, better scheduling adjusted to varying load conditions, etc. which can be accomplished by automatic vehicle monitoring and computerized dispatching can be worthwhile if they contribute to rider satisfaction and reverse the trend of riders away from mass transit.

The challenge therefore is: Can the mass transit systems be made sufficiently attractive to the non-riders to win them away from personal vehicles for some of their travel needs and thereby produce a better balance between use of personal vehicles (and all that that entails: highways, access ramps, parking space, etc.) and mass transit systems?

To this end the Subpanel* proposes that two Transit Improvement pilot projects designed to study means other than improved efficiency and comfort for increasing public acceptance of mass transit should be undertaken. The Subpanel also proposes that studies be made to determine the factors involved in selecting telecommunications alternatives to transportation.

References: Exclusive Bus Lane Programs

1. Washington, D.C. -- 10 miles of I-95 in northern Virginia between I-495 and the District of Columbia.

2. New Jersey -- 2 1/2 miles of I-495 from the New Jersey Turnpike to the Lincoln Tunnel (morning peak hours only).

3. San Francisco - Oakland Bay Bridge -- 1/2 mile of one lane of the toll plaza (morning peak hours only).

4. Seattle, Washington -- 9 miles of I-5 between fringe parking north of Seattle and downtown.

5. Similar projects are pending in Los Angeles, Pittsburgh, Milwaukee, Chicago, and Detroit.

*Subpanel on Transportation

Transportation

TRANSIT INFORMATION SYSTEM

I. Objective

To increase the attractiveness of mass transportation by provision of accurate information to prospective passengers without delay at curb-side bus stops and at transportation terminals.

Increased attractiveness is thought to be the key to a significant diversion from personal vehicles to mass transit for travel to and from the center city and within the city.

If this can be achieved, traffic congestion can be relieved, travel speeded, air pollution reduced, and costly new highways and parking pavillions in the center city areas avoided.

Another objective of the provision of this pilot project would be to create a sense of freedom of mobility within the city for the inner city dweller. This would particularly apply to those who by force of economics find it impractical to own a private vehicle. With this information system they would be able to easily obtain accurate information on routes and schedules to any part of the city or outlying areas.

The practical usefulness of this concept will be demonstrated if it produces a significant increase of usage of the mass-transit systems that participate.

This pilot project would utilize several of the city communication nets discussed in Chapter II of this report.

II. Project Outline

A. Nature and Scope -

The nature of this project is to rapidly provide information in response to signals from a box at a bus stop relative to routing, transfer points, schedules and estimated time of arrival (ETA). The first step would be manually processed information accessed by telephone; but full implementation requires a computerized vehicle dispatching system, with automatic vehicle location, "passengers waiting" and "passengers boarding and leaving" inputs.

Studies have been made of improved information systems, but these have been static systems, with information limited to that derived from printed schedules and route maps. The Mass Transportation Demonstration Project INT-MTD-10* was limited to bus stop markers, route indicators for the side of a bus, and timetable folders. The AC Transit, Oakland, California has instituted an improved information system, based on liberal distribution of bus schedules and route maps and an efficient manually operated information response to telephone inquiries. The calls come in over the public telephone system except for two directly connected street telephones.

The INT-MTD-10 project results were inconclusive, but in any case the project was not structured to increase usage of buses by non-riders.

The AC Transit reports an increase of riders, but it has simultaneously carried advertising and promotional programs, so that there is no measure of the effectiveness of the information system by itself as a means for increasing ridership.

This pilot project proposes to provide bus route and status information more rapidly, since it will be generated by a computer, and in the case of estimated time of arrival of the next bus it will be dynamic, being updated by inputs to the computer from an Automatic Vehicle Monitoring (AVM) system.

In addition, it proposes to present the information visually, rather than audibly, providing it more rapidly, while at the same time decreasing errors due to misunderstanding.

Information call boxes would be installed at the bus stops on a selected bus line connecting the perimeter of a city to the center, preferably at the intersection of cross town lines. The basic features of the call box devices might include a display screen and push buttons. The user could request information such as routing, arrival times and route identification. On the box would be a set of instructions for use and a map of the city marked with the destination numbers or codes.

If routing were requested, the bus routes, transfer points, and average trip time would be displayed on the screen.

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*Washington, D. C.

When ETA (estimated time of arrival) is requested, the control computer will determine and display on the screen (e.g., a cathode ray tube) the time, the route number, and direction of travel.

Provision could be made to dispense a printed schedule card for the selected route, either gratis or for a nominal fee. A fee might serve to discourage unnecessary taking of schedules.

The communications to and from the call boxes would be via a few narrow band channels of a broadband two-way, limited address, communication system as described in Chapter II of this report.

Use could also be made of a video distribution, narrow band call-back communication system to extend this information service to the home.

B. Project Implementation -

The Transit Information System pilot project should be applied to a mass transit system with a number of intersecting bus routes. It could also include one or more rapid transit rail lines.

1) Milestones -

a) Further detailed study beyond this project definition phase would be required. This study would provide:

- A study of the AC Transit, Oakland, California, information system. The study should seek to establish that increased patronage was due to the operation of the information system, and not to other concurrent factors. A study should also be made of other transit systems which have installed similar information systems.

- A determination of the operational characteristics of the Automatic Vehicle Monitoring (AVM) system that is necessary for this information service. These characteristics will be the same no matter which of the several types of AVM are used. They are characteristics such as: the accuracy with which location must be determined, the frequency with which a vehicle must be interrogated, the kinds of information needed, e.g., location, number of passengers on board, traffic delays or emergencies, critical vehicle readings such as engine temperature, etc. Interrogation and read-out time -- this may vary with the type of AVM system used. This study will indicate which of several urban AVM systems could best be used for the proposed service. It will indicate with what other city services an AVM system could best be shared.

- A determination of the operational features and capacity of the computer needed to implement the information service.

- A selection of the operational features of the call boxes with preliminary estimates for procurement, operation and evaluation.

b) Selection of mass transit system for implementation of the pilot project. This should be one with enough bus lines to provide frequent occasions for use of more than one line to complete a journey.

c) Systems design, including interconnection with the appropriate urban communications network and design of information call boxes. The report INT-MTD-10 will furnish helpful information on the physical appearance and aesthetics for these call boxes.

d) Implementation of the pilot system.

e) Intensive publicity campaign conducted by experienced public relations personnel to acquaint the public with the service and persuade them to use it.

f) Operation of the pilot system with planned collection of the data necessary for evaluation.

g) Evaluation of the results in terms of the increase in passenger miles that can be directly attributed to the implementation of the information system, versus cost.

2) Implementing Organizations -

The further detailed study should be made by a communications-oriented systems-engineering organization under contract from a government agency with cooperation from mass transit companies that have an innovative approach to urban transit problems.

Systems and equipment design should be done by private industry under contract to the mass transit company or authority which will operate the pilot project.

Implementation of the pilot project should be by the transit company or authority with municipal cooperation and with assistance from the industry contractor. The transit company or authority should also conduct the publicity campaign.

The Committee on Telecommunications might be requested to review and comment on the final plans for this part of the pilot project before implementation and participate in the evaluation of the project after it has been in operation for a suitable length of time.

3) Time -

After the equipment has been installed, the project should run for at least a year and preferably two years, as it will take time for people to change travel habits, even though they realize the convenience and economy of mass transportation. The implementation of the project as seen from the point of view of the bus company can be done in several distinct stages:

a) First, provide better information, available by phone, as to bus routes, schedules, and expected delays. To do this, trained public assistance operators should be provided on a 24-hour basis. These operators would be accessed by phone by a special number on a no-charge telephone basis to the caller. In addition, a number of special telephone instruments, without dialing mechanism, directly connected to these operators could be installed at a number of bus stops. The operators would be furnished with updated displays of bus schedules showing the time of arrival at each bus stop. In addition, they should receive from the dispatchers information on buses that are running late, or of incidents that are causing temporary stoppage or re-routing of buses.

b) After a computerized dispatching system utilizing AVM, providing bus location and operational information, has been installed, the public assistance operators would access the computer directly to obtain answers for callers.

c) When a suitable urban broadband communications system is in operation along the routes under test, the telephone instruments located at the bus stops could be replaced by the automatic call boxes, and the information converted from a manual audio system to an automatic visual system.

d) After the automatic visual information system is operative, its service could be extended in the future to the public in their homes over a number of the urban 30-channel video-distribution limited-address narrowband call-back communications systems, using the limited-address call-back features along with many other informational services.

While it would save time and money to implement c) directly without phases a) and b), if prior determination can be made that c) will be cost effective there could be an advantage to implementing a) and b) before going to c). If this was done and the effectiveness of b) evaluated, the further advantage of going to c) could be more readily assessed.

4) Location -

The suggested location of this project would be in a city large enough for severe vehicular traffic congestion to exist during peak travel hours and preferably one in which progress has already been made towards installation of computerized dispatching.

The mass transit system should consist of a number of intersecting bus routes, connecting a number of business, shopping, and industrial areas, with considerable travel requiring the use of more than one bus line to complete the journey. It is also desirable that the test city be one that attracts a significant number of visitors.

5) Evaluation Project -

The key evaluation criterion for this project would be the net increase or decrease in the daily average

number of passengers, corrected for any overall population trends, and other demographic changes during the life of the pilot project.

There are other evaluation criteria. These include: periodic counts of the requests for information, by type, e.g., routing, schedules, ETA, and category of caller, i.e., city resident, regular rider, occasional rider, visitor.

6) Cost -

Information Service

Detailed study:	$ 75,000
Implementation of phone system without computer, but including publicity campaign, with operation for one year -- 50 bus stop telephones:	$250,000
Implementation of system with 50 video call boxes, including publicity campaign, one year's operation, but not including computer or the automatic vehicle monitoring system:	$350,000

7) Method of Amortization - Source of Funds -

Pilot Project

Since most transit systems are in a precarious financial condition, and most municipalities are hard-pressed to meet present obligations, it would appear that the pilot project should be financed primarily by Federal funds. We would emphasize, however, that the management in the city chosen must be extremely enthusiastic and willing to extend itself to make the project successful; that would be the city's contribution.

III. Related Programs

It appears that as long as we have densely populated cities, there will be a continuing need of mass transportation; in fact, as cities grow in size, it will be more and more necessary for mass transportation to substitute for part of the personal vehicle travel to prevent strangulation. The proposed program is designed to integrate with the present system and to promote its use.

For the proposed improvement of urban transportation systems pilot system to be fully implemented, it will require implementation of computer-controlled dispatching.

Such dispatch systems require means of counting passengers waiting at a bus stop, by route to be taken, and direction of travel. It might be desirable to include prepayment of fare to speed loading.

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Transportation

TRANSPORTATION TRANSFER FACILITY

I. Objective

To increase the convenience of prospective passengers at terminal points and other points of interchange with major personal vehicle traffic flow.

II. Project Outline

A. Nature and Scope -

This pilot project would provide improved facilities for rapid, safe and convenient transfer from personal vehicles to mass transit lines, buses, or rapid transit rail lines, at the outer ends of the lines, or at strategic points intersecting major traffic flow patterns.

Parking lots at terminal points of mass transit lines have been effective in increasing patronage of these lines. One example of this is the Skokie parking facility of the Skokie Swift operated by the Chicago Transit Authority; for others see references on page 109. The Chicago authority is studying the construction of added parking facilities at rapid transit terminals. However, their full effectiveness in attracting riders to mass transit has not been measured since these lots lack the features that are proposed for this pilot project.

This project would involve providing parking space with low parking charges adequate to accommodate a large increase in all-day parking by mass transit patrons, equipped with features for convenience and safety described below.

This parking facility could be a parking lot or a multi-level parking structure. It is important that the facility be large enough so that patrons can reasonably expect to find parking space. Automatic means should be provided for locating a vacant parking slot. This requires a low-cost sensor at each slot, telecommunications to link each sensor to a simple computer, and displays to direct auto drivers to a slot. For a terminal handling several transit lines, direction should be given to a slot nearest to the transit line the patron wishes to use.

Rapid prepayment of parking fees, with the option of using credit cards should be provided. Since use of the parking facility will be limited to passengers, and, therefore, there will be no short-term parking, it might be practical to charge a flat fee and use a number of entrance lanes with fee-collecting devices that accept credit cards and return them after verification and charging done by a central computer.

Whether a multi-story building or a large lot is provided, there should be high level illumination and a uniformed guard on duty at all times, to protect cars and provide safety for people walking to and from their cars. In the case of the open lots, well-lighted and protected walks might be provided. For large lots, moving sidewalks could be useful.

The terminal itself should be provided with the information call boxes already described for use at bus stops, and devices for prepayment of fares.

Telecommunications are essential to this project. The information call boxes would be connected to the central computer. If credit card fare and parking fee payments are provided for, the collection devices will be connected to a central computer, probably a different one from that which controls dispatching.

Telecommunications for these facilities could be via a few narrowband channels of a broadband two-way, limited-address communication system with limited switching as described in Chapter II of this report.

The parking slot locating system would also need a communications system, but since this covers a limited area wire cables could be used.

B. Project Implementation -

The project test site should be at one or two terminal points for bus or rapid transit lines, or, alternatively, non-terminal points near which heavy personal vehicular traffic flows to and from the center of the city. The lines should connect between terminal points close to main vehicular arteries that are normally congested during business hours.

1) Milestones -

a) Further detailed study beyond this project definition stage would be required. This study would provide a survey of present parking and passenger handling facilities at travel media interchange points, particularly noting areas that appear to be most in need of improvement. One project that should be studied is the Skokie Swift, HUD project ILL-MTD-1 implemented by the Chicago Transit Authority, which has had impressive public acceptance. Determination of the performance requirements for components of the improved facilities to be provided, such as parking slot location, automatic fee collection, including computer requirements, moving sidewalks, etc. should be made.

b) Selection of transit terminal or transfer sites for implementation of the pilot project. These should be on transit lines which essentially parallel congested flows of road traffic to and from the center of the city. If bus-line terminals are selected, it is preferable that exclusive bus lanes in congested sections of the routes have been set up, or agreement with the municipal authorities is reached that they will be, before this part of the pilot project is implemented. It is desirable that there should exist at least one other terminal, without a parking facility, on another line, with similar traffic conditions, that could be used as a "control."

c) Design of sub-systems, including interconnections with a suitable urban broadband communications system, to satisfy performance requirements as determined in the study noted in paragraph a) above. Cook County, Illinois has a multi-stage garage under design for the terminal of the Kennedy Rapid Transit Line, but it does not include the telecommunications called for in this pilot project. The terminal will be an interchange between a suburban railroad, several bus lines, and a rapid transit line.

d) Implementation of the pilot system.

e) Execution of an intensive publicity campaign.

f) Operation of the pilot system, with collection of the data necessary for evaluation.

g) Evaluation of the results in terms of the increase in passenger miles that can be directly attributed to the implementation of the improved travel media interchange versus cost.

2) Implementing Organizations -

The further detailed study should be made by a traffic systems consulting engineering firm with assistance from a communications systems engineering firm under contract from a government agency. The study should be carried out with cooperation from mass transit companies and urban traffic agencies.

Implementation might be carried out by the municipal government or by the mass transit entity; in either case the close cooperation of the other would be needed. The systems and equipment contractor should provide assistance as needed. The implementing agency should also conduct the publicity campaign.

The Committee on Telecommunications might review and comment on the final plans for this part of the project before implementation and participate in the evaluation of the project after it has been in operation a suitable length of time.

3) Time -

The project should run after implementation one to two years. It is recommended that this project be done as a whole and not in stages.

4) Location -

The specific bus route or transit line selected for this project should: 1) run radially from the center city; 2) connect residential areas with the center city; 3) parallel a major flow of private vehicles in and out of the city; and 4) terminate at a logical point for transfer from personal vehicle to mass transit. It should be part of the same mass transit system for which the Transit Information System is implemented.

5) Evaluation Project -

The key evaluation criterion for this project would be the net change in the daily average number of

passengers, corrected for any overall population trends and other demographic changes during the life of the project. The existence of a similar terminal without parking facilities, but with very similar traffic conditions, would be a valuable reference point in determining influence of the pilot project on the use of mass transit.

There are other evaluation criteria, e.g., the percentage of riders, as determined by sampling techniques, who have switched from personal vehicular travel to mass travel to and from the city center, and growth of usage of terminal parking, corrected for any overall population trends, during the life of the project.

For the successful implementation of the two pilot projects, the information service and the travel media interchange improvements, the impact of political factors will be considerable. The city government must be persuaded that the goal of the pilot project is indeed the enhancement of urban living and that it is a practical approach to deal with one facet of urban problems, but not a panacea for transportation problems.

The social factors undoubtedly have the major impact on the pilot project's success. The most significant factors are reluctance to change habits in mode of traveling and to forego despite its inconveniences, hazards, and great cost, the supposed independence afforded by personal vehicle travel. As previously indicated, the implementation of the pilot project will need to include an intensive advertising campaign in news media, and by brochures, radio and TV, to inform the public of the new features such as the information service, and to persuade them of the advantages of using mass transportation rather than personal vehicles.

The economic factor is always present. To be a success the pilot project must show actual or potential economic gain commensurate with the cost. This gain can be direct, i.e., increase in fare revenue, or indirect, i.e., economic benefits due to avoidance of costly new highway projects, inner city traffic handling or parking, and reduction of losses due to atmospheric pollution.

6) Cost -

Travel Media Interchange Improvement

Detailed study: $100,000

Cost of the parking facility would depend on outcome of detailed study and the location selected.

7) Method of Amortization - Source of Funds -

It would appear that the funding provision of the Urban Mass Transit Act is the principal avenue for financing this project.

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AN ECONOMIC STUDY OF COMMUNICATIONS ALTERNATIVES TO URBAN TRAVEL

I. Objective

To study the social and economic effects of enhanced telecommunications which could reduce the need for travel in the urban environment.

II. Project Outline

A. The study would seek to determine what social and economic effects would be caused by the introduction of enhanced telecommunications which could reduce the need for travel in the urban environment. This would be studied from the points of view of optimizing the use of existing telecommunications networks and from the use of enhanced characteristics such as two-way broadband cable systems.

B. Project Implementation Details -

1) Milestones -

a) Design of procedures to accomplish the various steps in the project.

b) Perform analysis of travel versus function. The data would be obtained by means of sampling of purpose of travel to the center city for both those who travel by personal vehicles and those using mass transit. By means of case histories of smaller size samples determine why the subjects felt that they had to travel rather than use communications, including mail, to achieve their purposes. Analyze data to determine the types of personal contact functions that are amenable to replacement by communications, with a further breakdown by private vehicle and mass transit users.

c) Evaluate the potential, for substitution by telecommunications, of travel for various functions. This would be a number of empirical studies, along the lines of those being carried on in England by Mr. Alex Reid. A particular area as yet not rigorously studied is multi-party conferencing via audio or audio/visual telecommunications.

d) Develop a data base which would include the data obtained from the travel versus function analysis and the substitution potential evaluation. Also, two categories of dollar values should be determined by hourly time increments for such tangible transactions as retail sales, wholesale orders, stock brokerage, banking, municipal government fees and taxes, etc. The two categories of data accumulation should be for transactions made through personal contact and those made through communications (telephone, telegraph, or mail). Finally, two similar categories should be developed by assigning costs to the exchanges of business and technical information that are accomplished through travel and conference and those that are completed by use of telecommunications.

e) Develop a model to predict changes in gross local product as dollar exchange volumes are shifted from personal contact to telecommunications in the various sub-categories described in the data base.

f) Evaluate the means to implement alternatives with public acceptance. Assuming the third milestone had shown that there was a significant amount of travel to the center city that could be replaced by various telecommunications without serious social complications, there would be a need to determine the economic balance between new telecommunication systems and the amount that travel would be reduced. In addition, a study should be made of the means to persuade those making unnecessary trips to make the shift, once the necessary telecommunications systems become available.

2) Implementing Organizations -

This project would appear to be best handled by a nonprofit research organization under federal funding, in consultation with industry, other research organizations, and the NAE.

The actual survey of the requirement for travel could be subcontracted to a professional poll-taking organization.

3) Time -

The project naturally falls into distinct phases that can follow in sequence:

Design of procedures	3 months
Analysis of travel vs. function	6 months
Evaluation of potential for substitution	6 months
Development of data base	3 months
Development of model	3 months
Evaluation of implementation with public acceptance	3 months
Total time for complete project	24 months

The analysis of travel vs. function should extend over at least 6 months, including winter and summer weather so that effects of weather on travel habits could be observed, and the final results averaged on an annual basis.

If the analysis of travel vs. function showed that little travel was for functions that appear amenable to substitution by telecommunications, then completion of the four remaining phases would not be justified.

4) Location -

The analysis of travel vs. function should be made in several major cities in different parts of the country, for example, Los Angeles, Chicago, and New York.

5) Evaluation Process -

The criterion of project evaluation would be the degree to which meaningful data was obtained as to function of travel, the potential for substitution, and the means of implementing such substitution. The social factor would be of great importance in the latter.

6) Cost -

Design of procedures	$ 16,000
Analysis of travel vs. function	63,000
Evaluation of potential for substitution	60,000
Development of data base	30,000
Development of model	30,000
Evaluation of implementation	30,000
Total:	$229,000

7) Method of Amortization - Source of Funds -

The nature of this pilot project indicates that it should be supported by federal funds without amortization.

C. Related Programs -

This program has direct bearing on programs concerned with transportation, both private vehicle and mass transit. To the degree it is successful, it could indicate an alternative to at least parts of these programs.

If this study indicates that there is a realistic possibility of a significant economic substitution of telecommunications for transportation, a further pilot project should be undertaken to demonstrate this concept.

D. Growth Potential -

Provided substantial substitution is indicated as achievable and the telecommunication systems necessary for this are identified, the concepts could be applied in all major cities.

No projections can be made on a mass basis until a demonstration pilot project is undertaken.

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***

Subpanel on Transportation: Richard P. Gifford (chairman), Ernst Weber, George L. DeMent (deceased, March 13, 1971), Hugh H. Davids (advisor), Ralph W. Tracy (advisor), and Richard C. Hopkins (staff).

Crime Prevention and Emergency Services

CRIME PREVENTION

Introduction

> Fear of crime is destroying some of the basic human freedom which any society is supposed to safeguard -- freedom of movement, freedom from harm, freedom from fear itself. (our underscore) -- National Commission on the Causes and Prevention of Violence

The objective of the Subpanel on Crime Prevention has been to study how telecommunications technology might help combat the large cities' crime problems. In the initial phase of its study the Subpanel selected a type of crime which by its nature and by its frequency is a major cause of fear in the urban environment.

After discussing the crime problem with police officials and after reviewing the findings of the President's Commission on Law Enforcement and Administration of Justice and the National Commission on the Causes and Prevention of Violence, the Subpanel has concluded that the most important consideration should be the chronic fear that city dwellers feel as a result of crime. Robbery is a major cause of this fear.* Both the nature of this crime and its frequency support this conclusion.

In most cities, robbery accounts for about two-thirds of the violent crimes.** More significantly, robbery is the violent crime most often committed by a stranger and, therefore, a major source of fear.

In order to put into perspective the amount of money that might be spent to prevent robbery, the Subpanel has estimated the total expenditure by the public for police, court, and corrections as a result of robbery in New York City.***

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*Robbery is defined as the taking of property from a person by use or threat of force with or without a weapon.

**The violent crimes are homicide, rape, assault, and robbery.

***New York City has been used as a data base for much of this study and, whereas statistics in other cities may vary, large cities share similar crime problems.

For the 60,000 robberies reported in 1969, this expenditure totals about $45 million. By dividing this amount by the 60,000 occurrences in 1969, one derives an average cost of $750 to the public for each robbery reported (see Figure 1).*

It is important to note that this figure does not include welfare payments to families where the wage earner is incarcerated, and no reimbursement is made out of public funds for a victim's property or personal damage.

To be sure, a case can be made that it is reasonable to spend more to prevent robbery than is spent to respond to robbery. High rates of recidivism indicate that, despite the expenditures to operate the correction system, many criminals are not being rehabilitated. In fact, the system appears to foster criminality among younger offenders (note recycling arrows in Figure 2).

In addition, the following considerations belie the saying that crime does not pay, and they strongly suggest the absence of fear of punishment:

a) Many robbers are not caught. Several studies suggest that only half of the robberies committed are ever reported.

b) The ratio of robbery arrests to robbery complaints was 0.18 in 1969; and it is estimated that of the persons arrested, one in twenty are incarcerated. Therefore, out of every 110 robberies reported, one jail sentence results (see Figure 3).

Finally, it should be kept in mind that it is difficult to quantify the effect of fear on the individual and on the community.

While robbery occurs as often indoors and outdoors, the opportunities for protecting homes and apartments are more advanced than those for protecting the citizen on the street. The Subpanel has reviewed many of the present and proposed applications of communications technology to the street crime problem. A promising deterrent to street robbery is twenty-four hour television surveillance of streets. The Subpanel proposes that this concept be further studied, implemented and evaluated.

*This figure represents a range from the cost of a robbery which is never solved to the cost of a robbery in which several men are convicted and given maximum sentences. A detailed presentation of the data from which this average cost figure is derived will be found in the Urban Panel's Interim Report, August 1970, pages 19-35.

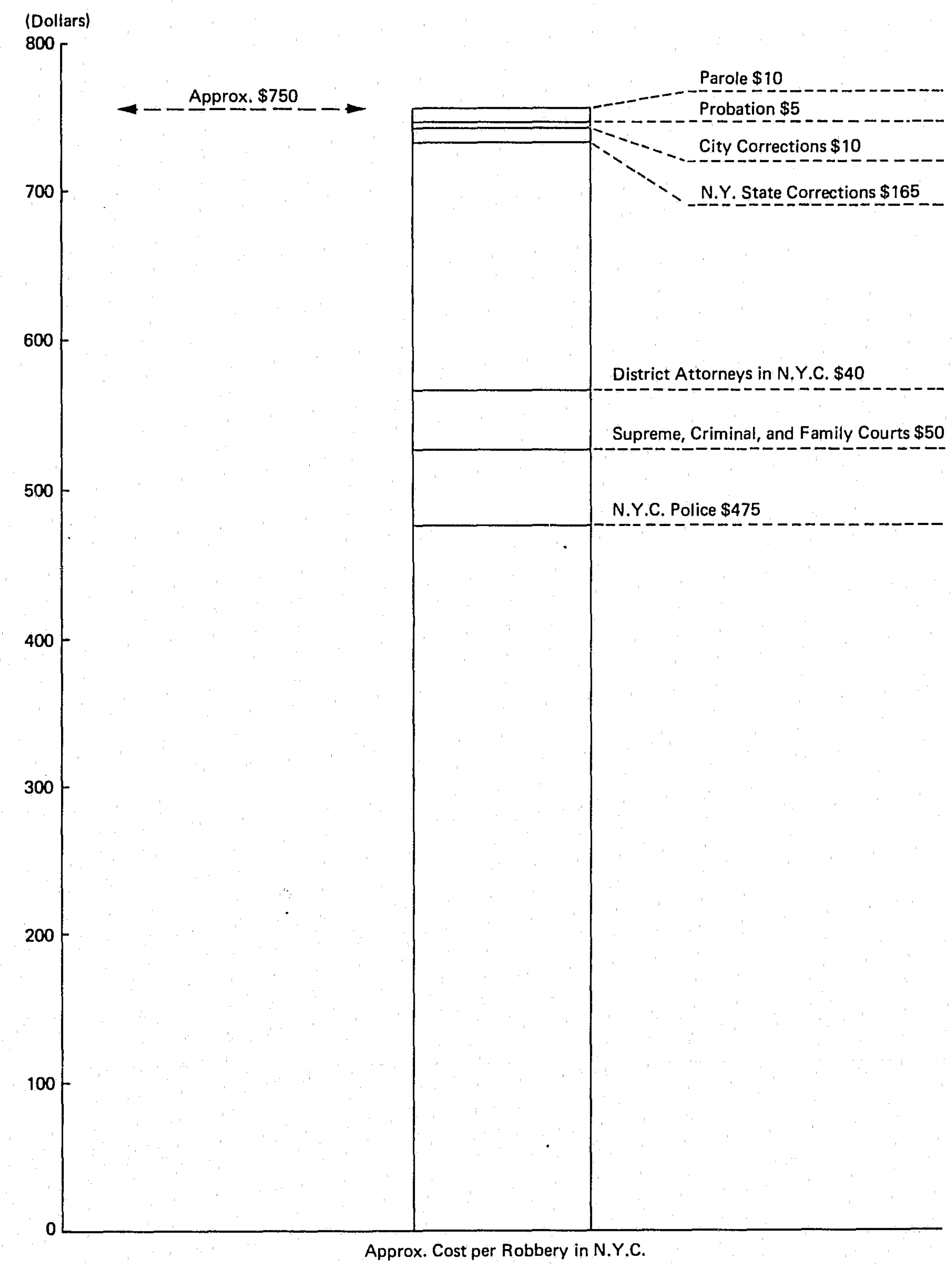
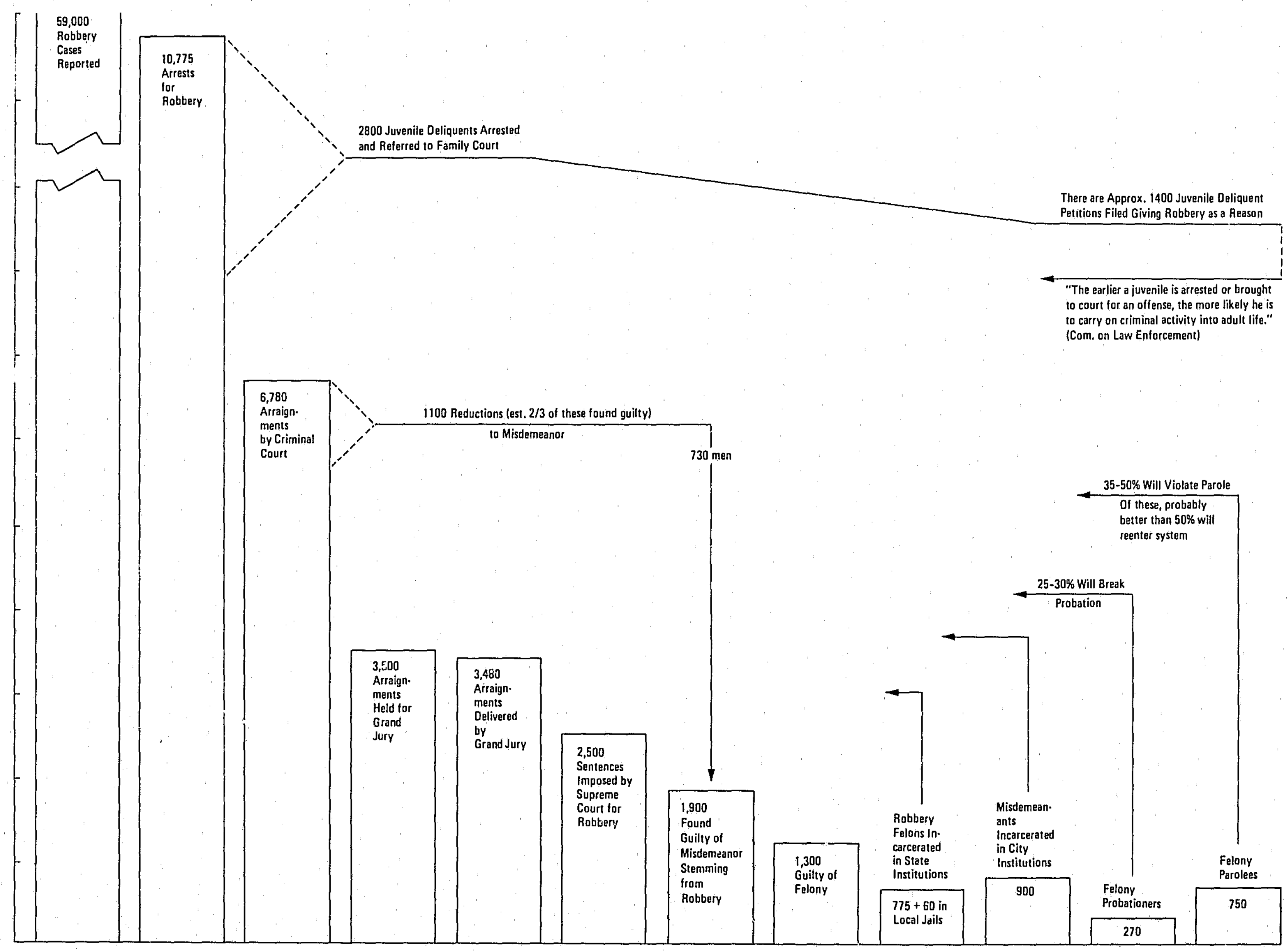


Figure 1



59,000 Robbery Cases Reported
10,775 Arrests for Robbery
2800 Juvenile Deliquents Arrested and Referred to Family Court
There are Approx. 1400 Juvenile Deliquent Petitions Filed Giving Robbery as a Reason
"The earlier a juvenile is arrested or brought to court for an offense, the more likely he is to carry on criminal activity into adult life." (Com. on Law Enforcement)
6,780 Arraign-ments by Criminal Court
1100 Reductions (est. 2/3 of these found guilty) to Misdemeanor
730 men
35-50% Will Violate Parole
Of these, probably better than 50% will reenter system
25-30% Will Break Probation
3,500 Arraign-ments Held for Grand Jury
3,480 Arraign-ments Delivered by Grand Jury
2,500 Sentences Imposed by Supreme Court for Robbery
1,900 Found Guilty of Misdemeanor Stemming from Robbery
1,300 Guilty of Felony
Robbery Felons In-carcerated in State Institutions
775 + 60 in Local Jails
Misdemean-ants Incarcerated in City Institutions
900
Felony Probationers
270
Felony Parolees
750

Figure 2

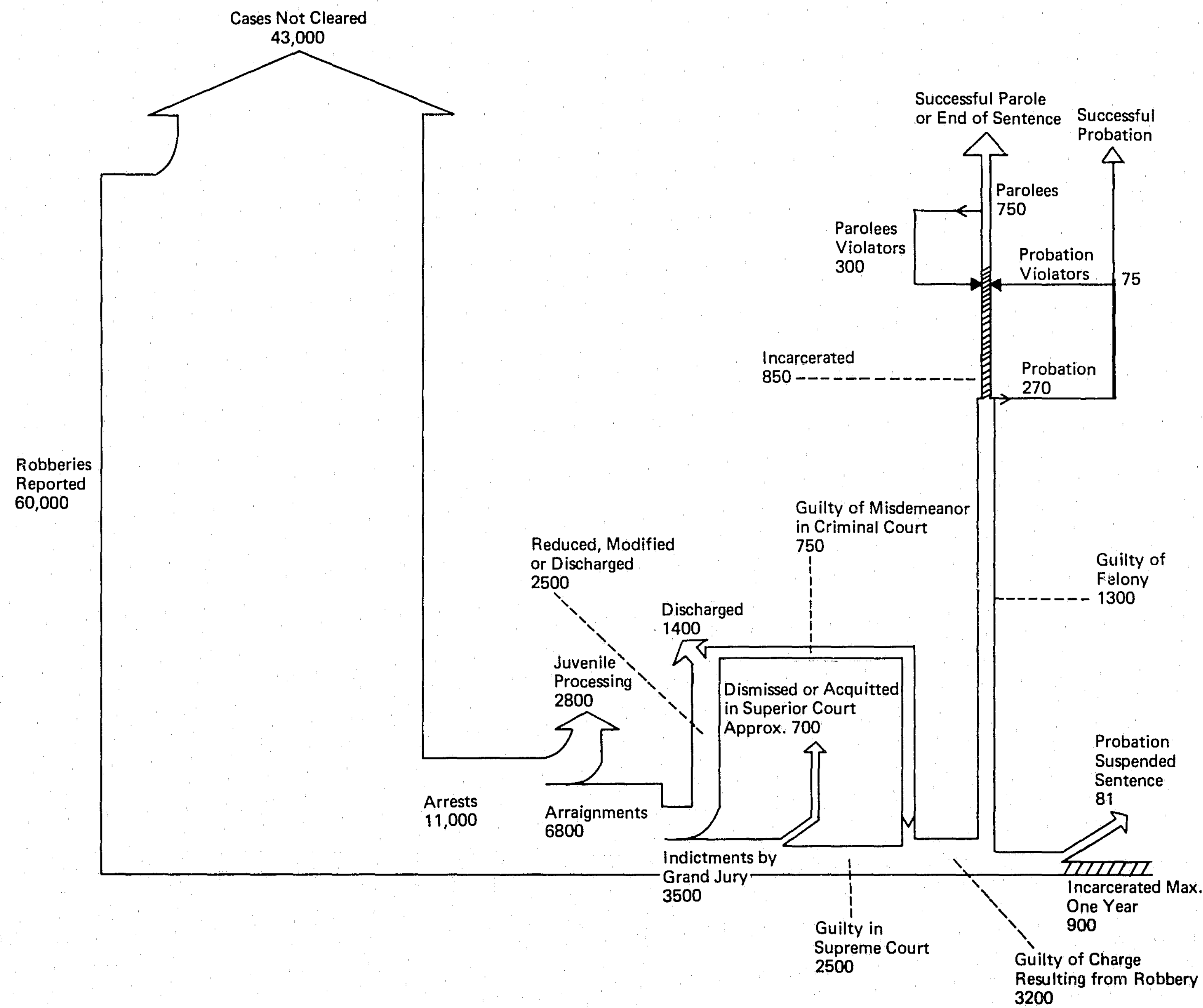

Cases Not Cleared
43,000
Successful Parole
or End of Sentence
Successful
Probation
Parolees
750
Parolees
Violators
300
Probation
Violators
75
Incarcerated
850
Probation
270
Robberies
Reported
60,000
Guilty of Misdemeanor
in Criminal Court
750
Reduced, Modified
or Discharged
2500
Guilty of
Felony
1300
Discharged
1400
Juvenile
Processing
2800
Dismissed or Acquitted
in Superior Court
Approx. 700
Probation
Suspended
Sentence
81
Arrests
11,000
Arraignments
6800
Indictments by
Grand Jury
3500
Incarcerated Max.
One Year
900
Guilty in
Supreme Court
2500
Guilty of Charge
Resulting from Robbery
3200

Figure 3

To ascertain whether existing low-light-level cameras would be suitable for street surveillance, the Subpanel conducted both laboratory tests and an exhaustive series of tests employing a number of LLLTV (low-light-level television) cameras on typical street locations. Based on these experiments the camera requirements for a 24-hour surveillance system could be defined as follows:

1) During the day, when general ambient illumination rather than street lights or automobile lights exist, the camera must automatically compensate for the amount of ambient light. All cameras tested were able to do this adequately.

2) At night, when the illumination is provided by discrete light sources, namely street lamps, and where moving vehicles, street signs, traffic lights, etc. introduce highly concentrated bright light spots in the picture, the camera must maintain full resolution and visibility in the surrounding dark areas. The expected saturation of the bright highlights on the video image should not spread beyond these into the unilluminated darker areas.

The second condition has not been met by any of the cameras so far tested. Specifically, they tend to equalize for the very bright small area light sources in such a way that in the surrounding areas, up to about a 10-ft. distance from the bright source, events taking place in the low ambient illumination are virtually undetectable. Following the earlier tests, two manufacturers indicated their desire to demonstrate cameras so far not considered. In April 1971 this demonstration took place. Essentially, the two cameras showed the same behavior as outlined above and, therefore, in their current condition could not be recommended for a 24-hour street surveillance system.

Several of the cameras tested have adequate sensitivity and resolution to give good picture rendition in uniformly dark areas at night time with incident light levels of the order of 0.02 to 0.05 foot-candles.

It is the Subpanel's opinion, based on the detailed findings of these tests, that camera manufacturers may be able to modify or improve existing camera systems to satisfy the requirements for an effective 24-hour surveillance camera. The manufacturers have been encouraged to return their equipment for further testing, if they feel that some of the difficulties noted have been remedied. Assuming that a suitable camera becomes available, the Subpanel proposes a Television Surveillance Project.

Although the problem of street robbery has been a dominant concern, the Subpanel has also addressed two other issues relevant to the alleviation of fear and crime. The high incidence of all types of crime in and around high-rise urban housing causes fear inside the homes of many city residents. The Subpanel is submitting a recommendation for an Urban Public Housing and Institution Security project which deals with this problem.

To enable police, fire, ambulance, and other emergency services to respond more rapidly and accurately, there is a need for a system to identify the origin of calls made to an emergency operating center. The Crime Prevention Subpanel recommends the development and implementation of an automatic location identification system for emergency operating centers.

It is the Subpanel's conviction that the benefits of communications technology to all aspects of the criminal justice system are just becoming apparent and every effort should be made to reap these benefits.

At the same time, the adverse social implications of electronic surveillance for crime deterrence need to be fully considered prior to the adoption of these techniques. Public concern is growing with respect to the invasion of the individual's privacy inherent in the widespread and indiscriminate use of this technology. Such use should therefore be on a selective and carefully controlled basis. The public, too, needs to be made aware of the reasons for the resort to this technology in selected situations.

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TWENTY-FOUR-HOUR TELEVISION SURVEILLANCE OF STREETS (Crime Prevention)

I. Objective

The objective of this pilot project is to ascertain the extent to which a television street surveillance system would deter street crimes and help alleviate the citizens' fear of being on the street. It is hoped that the proposed system would be a powerful crime deterrent by providing police with an efficient means to detect crimes in progress and potentially dangerous situations on the street. For maximum effectiveness, the system would have to be fully integrated through walkie-talkies and car radios with a highly mobile police patrol force.

II. Project Outline

A. Background and Scope

The Subpanel proposes that an experimental television surveillance system be designed, installed and tested, and that the demonstration project cover approximately two square miles within a typical urban area. The purpose of this project is to determine the deterrent value of the television surveillance technique and to make the following analysis:

1) How well can one discriminate between justified, suspicious and illegal action as seen on a television monitor?

2) What is the optimum use of this system in conjunction with existing dispatch systems (e.g., the SPRINT System in New York City), foot and vehicle patrols, and other communications systems?

3) What combination of television surveillance system and police communications and patrol will achieve the desired results?

4) How can the television system be used to improve the collection of evidence; e.g., tape, disc, and other methods?

5) What additional benefits are offered by the television system; e.g., ability to trace a criminal's escape route and identify witnesses?

6) What is the best way for the system's effectiveness to be made known to the potential criminal so that he is deterred from committing crimes?

Some of the parameters applicable to the proposed pilot project are indicated by the Subpanel's studies using the 71st Precinct in New York City (Brooklyn) as a model. In selecting this precinct the Subpanel took into account the close correlation of robbery rates per 10,000 population between the city and this precinct, and that the city rate of robbery per square mile approaches that for the 71st Precinct (if allowances are made for the size of the unusually large Richmond precincts). In terms of robbery occurrences, this represented an average precinct (see Figure 4).

It was determined that 140 cameras would be needed to survey the 58.5 miles of streets in the 71st Precinct (see map, Figure 5). Each of these cameras could be mounted on lamp poles at intersections and be positioned on pan-and-tilt units that permit 360-degree rotation. The camera would rotate automatically through 360 degrees once every minute, stopping for 10 seconds at each of four positions corresponding to the four street scenes visible from an intersection. The camera tests conducted by the Subpanel indicated that a camera equipped with a 15 mm to 150 mm zoom lens is able to survey a distance of up to 1,000 feet. In this model it was assumed that the 140 cameras would feed their signals by cable into the precinct headquarters where the monitoring takes place. There would be one monitor for each camera and 35 men (civilian personnel) could survey all the precinct's streets once every minute.

The cost of operation, including maintenance and salaries, and capital cost (amortized over a five-year period) of this model system was estimated to be approximately $1.5 million per year (Figure 6).

It was assumed that in this model the existing contingent of police would continue its patrol. To be most effective, the television system would have to be closely coordinated with the police foot and vehicle patrols through the use of walkie-talkies and car radios in order to dispatch immediately personnel to a trouble spot appearing on the monitor.

One way to evaluate the television model surveillance system is to compare the coverage it affords for its cost ($1.5 million) to the coverage obtainable by applying the same expenditure to more policemen or car patrols.

DATA FOR PRECINCT SELECTION

77 Precincts

	New York City	Average Precinct	71st Precinct
Total Population	approx. 8,000,000	approx. 104,000	200,000
Whites	80%		
Blacks	14%		
Puerto Ricans	5%		
Area	320 square miles	4.1 square miles*	2.5 square mi
Miles of streets	approx. 6,000 mi	79 miles	58.5 miles
Net robberies reported	approx. 59,000	766	1,446
Robberies per 10,000 population	74		72
Robberies per square mile	184	184**	578
Number of blocks			285
Robberies per block			5 (approx. 50% outdoors)
Illumination			
Residential	less than 1 ft-c***		(being obtained for random sampling of commercial and residential streets)
Manhattan	1½ ft-c		
5th Avenue double luminar	3 to 4 ft-c		
6th Avenue lucalor yellow	3 to 4 ft-c		

*Manhattan and Brooklyn precincts are about one-fourth this size. Huge Richmond and Queens precincts make this figure high.

**If the large Richmond and Queens precincts were excluded, this figure would be substantially greater.

***Abbreviation for foot-candle.

Figure 4

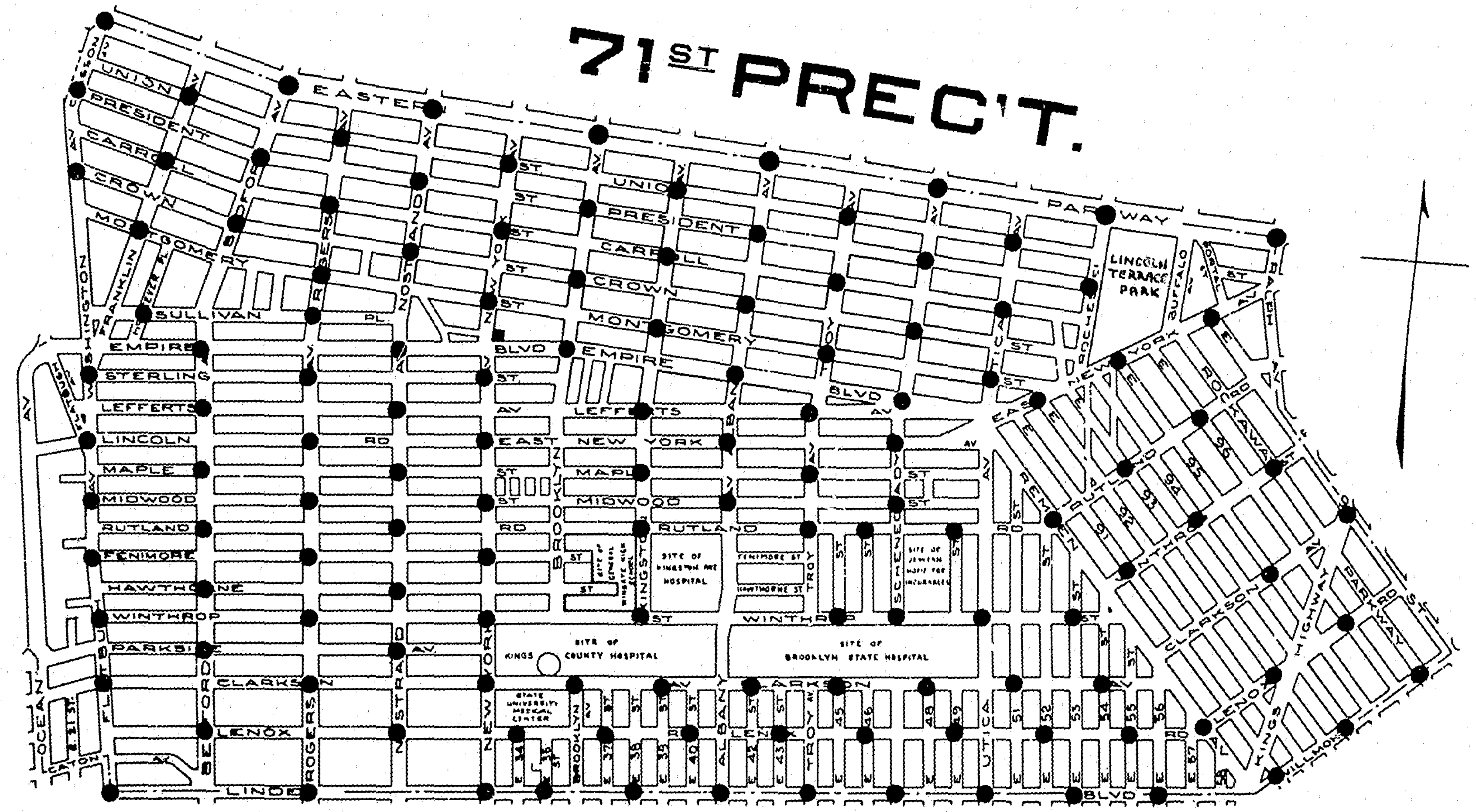
71ST PREC'T.
EASTERN PARKWAY
UNION
PRESIDENT
CARROLL
CROWN
MONTGOMERY
SULLIVAN PL
EMPIRE BLVD
STERLING
LEFFERTS AV
LINCOLN RD
EAST NEW YORK AV
MAPLE ST
MIDWOOD ST
RUTLAND RD
FENIMORE
HAWTHORNE
WINTHROP ST
PARKSIDE AV
CLARKSON AV
LENOX RD
LINDEN BLVD
WASHINGTON AV
FLATBUSH
OCEAN
BEDFORD
ROGERS
NOSTRAND
NEW YORK
BROOKLYN
KINGSTON
ALBANY
TROY
SCHENECTADY
UTICA
REMSEN
RALPH
BUFFALO
ROCKAWAY
KINGS HIGHWAY
LINCOLN TERRACE PARK
SITE OF KINGS COUNTY HOSPITAL
SITE OF BROOKLYN STATE HOSPITAL
STATE UNIVERSITY MEDICAL CENTER

Figure 5

Figure 6

Surveillance Project Cost

Capital Costs

1)	140 cameras in protective housings with remote pan-and-tilt; approximately $15,000 per unit:	$2,100,000
2)	70 miles of coaxial cable; approximately $5,000 per mile* to purchase and install (rental should be considered):	350,000
3)	70 miles of pan-and-tilt control wire; approximately $1,000 per mile to purchase and install (rental should be considered):	70,000
4)	Computer:	15,000
5)	140 16-inch monitors at $250 per monitor:	35,000
6)	Other electronics, switchers, etc.:	120,000
	Total:	$2,690,000

Yearly Maintenance and Operation Cost

1)	System maintenance estimated as 15% of capital investment per year:**	$ 400,000
2)	Salaries for 175 viewers (assuming a pay rate of $2 per hour, and 5 shifts per day of 35 men, and each man responsible for 4 monitors. (This figure excludes overhead which is expected to be minimal.):	613,000
	Total:	$1,013,000

Total Yearly Cost

1)	Capital cost amortized over 5 years:	$ 538,000
2)	Maintenance and operation:	1,013,000
	Total:	$1,551,000

*Seiden, M. H., *Report to the Federal Communications Commission, An Economic Analysis of Community Antenna Television.*

**Greenberg and Barnett, *A Proposal for Wired City Television,* "If cost for capital charges (of the investment cost of wired city poles, conduits, wire, droplines, and installation) and maintenance is expressed as an annual rate relative to investment, we would guess it is about 15 or 20 percent." page 26.

The yearly cost to the public of one patrolman's salary and fringe benefits is approximately $16,400.* At this rate, 94 patrolmen could be added to the 71st Precinct's patrol force. Because there are three tours of duty during a 24-hour period, only one-third of these men could be on the street at any given time of the day or night. If a man walks at an average rate of 3 miles per hour, these men on foot patrol could cover only 2% of the precinct's streets in one minute. Using the LLLTV model surveillance system, the entire 71st Precinct could be monitored once every minute.

As another comparison it is estimated that it costs about $100,000 per year to maintain a two-man police car on a 24-hour patrol.** Accordingly, 15 vehicles could be added to the patrol force in the 71st Precinct for $1.5 million. If the average speed of a patrol car is 25 miles per hour, then 15 cars altogether cover only 6¼ miles in each one-minute period.

These comparisons serve to illustrate a means of measuring the usefulness of the television surveillance system. For more concrete analyses, an actual demonstration of the television surveillance concept is needed.

B. Project Implementation

1) Milestones

A first task is to evaluate the existing small-scale projects, such as:

- Olean, New York: an eight-camera experiment no longer operational that achieved mixed results.
- Mt. Vernon, New York: a two-camera system funded by LEAA that became operational in April 1971.
- Hoboken, New Jersey: a small system similar to Mt. Vernon's is planned.

Because these installations are relatively small, the findings concerning their operations are likely to be more significant

*Criminal Justice Coordinating Council, *Criminal Justice Plan for 1971.*

**Commission on Law Enforcement and Administration of Justice, *Science and Technology*, page 14.

than those concerning their effect on crime. It should be kept in mind that in these projects only a few blocks are surveyed and there are unsurveyed areas close at hand in which criminals can continue their activities.

Assessments of these projects should allow for the technical performance of the cameras used. Based on favorable findings and assuming that a suitable camera is available, a demonstration project should be designed and undertaken.

2) Implementing Organizations

The implementing organizations should include the Department of Justice, a municipal government, a systems engineering firm, a contractor, as well as a group of the community's representatives. An experiment of this nature should proceed only with the support and step-by-step participation of the community. Efforts should be made to involve and to educate the citizens of the community about the proposed system's use and purpose, and they should be invited to cooperate with the police in determining the guidelines by which the experimental system would be operated.

3) Time

The Subpanel estimates that once suitable cameras are available, the time requirements for the proposed project would be:

a) Six months to design the system, to set up appropriate plans for community involvement, and to determine the factors and controls by which the system should be evaluated. During this phase and in subsequent operation, consideration should be given to the extent that other municipal organizations besides the police can share the use and cost of the television system; e.g., traffic, fire, and sanitation departments.

b) Six to ten months for installation.

c) Twelve months for operation and evaluation.

4) Location

The pilot system should be installed in a typical urban area (in terms of building and street configuration, population density, etc.) and cover about two square miles. In recommending a pilot system of this size the Subpanel has

taken into consideration that crime varies from neighborhood to neighborhood according to social and physical factors. Therefore, at least one neighborhood should be entirely covered by the surveillance system. A second consideration has been that the few small-scale surveillance experiments underway do not cover large enough areas to yield conclusive results.

The Subpanel recommends that the demonstration area selected have an average rate of street crime in relation to the rest of the city. This would insure that the findings are broadly applicable.

5) Evaluation Process

It is suggested that one year be considered as a minimum period for operation and evaluation since the amount and nature of crime is cyclic, varying in part according to season. For evaluation purposes, the occurrence of all crimes both within and around the test area must be carefully recorded before, during, and after the system's operation. Based on this data the final assessment of the system's performance and value should take into account the system's capital and operating costs and the community's reaction. It is expected that some legal questions would emerge as a result of this project. The resolution of these should affect the final assessment.

6) Costs

From preliminary studies made for a model system, the Subpanel estimates the yearly cost of the proposed pilot system for an area of two square miles would be:

Capital costs (amortized over a period of five years):	$0.5 million
Operation, including maintenance and salaries:	$1.0 million

C. Related Programs

The application of television surveillance to prevent street crimes is the subject of a small-scale pilot program underway in Mt. Vernon, New York and of another one planned for Hoboken, New Jersey.

Other possible means of deterring street crime are the use of a personal alarm, which is discussed in the Urban Public Housing Security Project, and better illumination of streets at night. These two concepts could be also integrated with a television street surveillance system.

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URBAN PUBLIC HOUSING AND INSTITUTION SECURITY
(Crime Prevention)

The incidence of crime in urban housing projects has been rising nationally, posing an increasing threat to the personal safety and property of many tenants. Although a complete solution to this insidious problem awaits fundamental social change, significant improvements are feasible now. By imaginatively applying established and advanced technologies, by educating the community on simple preventive measures, and by inculcating community responsibility for security, many of the advantages which have been laid to the unorganized criminal and opportunist can be reversed.*

The fear of crime has invaded the homes of many urban dwellers. This same fear has invaded the public schools their children attend.

I. Objectives

The Crime Prevention Subpanel recommends an Urban Public Housing and Institution Security study and implementation project that would integrate electronic security techniques with a semi-private force of security personnel to help eliminate crime and fear in public housing and public institutions, such as schools.

II. Project Outline

A. Background and Scope

Key elements in this security system could include acoustic surveillance using microphones to monitor certain interior areas, a system of low-light-level television cameras, and a personal alarm system to protect housing project inhabitants and their property in both interior and exterior areas. These key elements and other security measures, such as those

*Report of the New York City Security Panel, *Some Alternatives for Security Improvement in High-Rise Public Housing and a General Format for Ranking Effectiveness*, The Rand Corporation, New York.

recommended by the New York Security Panel would be optimally integrated with a contingent of housing authority police, or with other appropriate security personnel.

It should be stressed that this security system is meant to complement the existing municipal public safety resources, e.g., police, fire, etc. The concepts discussed here are for limited and well defined areas and are meant to provide the individuals within these areas with effective deterrents to crime and with significantly improved response time in obtaining some initial assistance in emergency situations.

The use of semi-private security personnel would provide a buffer between the citizen and the municipal police department. This buffer would perform two necessary functions; namely, decrease the false alarm problem inherent in every private security system connected directly to the police department* and, at the same time, provide a degree of local citizen participation in the processes of the Public Housing Security System. A thorough systems analysis would have to be carried out to ascertain such things as how best to assign manpower resources between patrol and monitoring duties.

Personal Alarm

The citizens of high-rise dwellings might be equipped with a sonic device that could be triggered once and would result in the dispatching of aid from an intra-dwelling security force.

The activation of such a device (e.g., a small pocket-sized ultrasonic transmitter) would be sensed by a receiver located in a hallway or apartment which would alert the security force to the occurrence and location of a crime or potential problem. Such devices are currently under development and test.** They have been used by teachers in a California public school and are proving successful. To prevent misuse, a device could be designed so that once triggered, it would have to be reset by the appropriate responding authority before it could be reused.

*Small Business Administration, *Crime Against Small Business*, report transmitted to the Select Committee on Small Business, United States Senate, April 3, 1967, Document No. 91-14.

**Jet Propulsion Laboratory, Pasadena, California, *Interim Report on Private Alarm Signaling System (PASS)*, Space Technology Applications, Task 126, National Aeronautics and Space Administration, Washington, D.C., December 11, 1970.

Acoustic Surveillance

Acoustic monitors have been found to be highly effective for monitoring enclosed areas that are normally not occupied. This would include such areas as basement washrooms during the late evening and night periods and storage and vacant apartments throughout the day. A threshold circuit is set for each of these areas in relation to the area's normal background noise level. Any increase in this background noise level triggers the threshold device and signals an alarm.

Television Surveillance

It is proposed that one aspect of the security project would be a closed circuit television system, which is likely to be most useful for protecting outdoor areas such as playgrounds and parking lots and for monitoring entrances and elevators. It should be noted that existing television technology is able to handle most of the lighting conditions found in a housing project.

The television cameras could be monitored by appropriate security personnel and it has been suggested that the signals of certain cameras be fed to the television sets of the residents. In this way, a resident could monitor the lobby or watch his children in the playground.

The devices singled out here (i.e., Personal Alarms, Acoustic Surveillance, and LLLTV Cameras) are the major elements of a Public Housing Security pilot project.

B. Project Implementation

1) Tasks

The first task in this pilot project would be a study of the telecommunications security devices which might be useful for protecting interior and exterior areas of a typical high-rise housing environment. Determinations would be made of the technical dependability of the security devices and of their susceptibility to intentional and unintentional misuse. When these characteristics are ascertained and the different sizes of housing complexes are taken into account, a systems analysis would be carried out to determine the optimum combinations of the various security techniques and manpower resources.

Based on the findings of this study, and as the second phase of the proposed project, a security system should be designed, installed, and evaluated in an urban public housing complex.

2) Implementing Organizations

The implementing organizations should include a private, nonprofit research firm, a municipal government, and an appropriate public housing authority.

Integration of this pilot project into the joint Department of Housing and Urban Development and Department of Justice's Law Enforcement Assistance Administration efforts* is highly endorsed.

3) Time

The time requirements for the proposed project are estimated to be:

6 to 8 months for study

6 months for planning, installation, and test of the pilot system

12 months for operation and evaluation

4) Location

It is recommended that the security system be tested in a public housing complex which is typical in terms of size and number of buildings, rate of crime, demographic characteristics, etc.

5) Evaluation

The major factor to be evaluated would be the success of the system in reducing the incidence of fear of crime in the test location; therefore, records should be kept of the crime within and around the test area both before, during, and after the operation of the security system.

6) Cost

For planning purposes, the major cost factors of the proposed project are estimated to be:

Study phase (for 5 men for 6 months):	$100,000
Implementation phase (for 100-unit building):	$300,000 to $400,000

*U.S. Department of Justice, Law Enforcement Assistance Administration, Request for Proposal No. J-002-LEAA, *Crime In and Around Residences and Security Systems for Dwellings*, February 1, 1971.

While the components of the television system and acoustic system are available, a major item in the cost figure stated above is translating the public school system personal alarm technology into the public housing environment. This will necessitate a review and re-evaluation of the sources of false alarms. This task would require a study and test phase of six months and $75,000. Following the false alarm study and test phase, approximately $50,000 would be required for production engineering before these devices can be used in a pilot project environment. For a 100-unit town house complex currently under rehabilitation it would cost an additional $18,000 for hardware and wiring. This sum would provide 100 transmitters, 100 microphone/receivers and one display console. Six months would be adequate for planning, installation, and test following a six-month production engineering effort.

It would appear that the security communications system for a public housing complex would not be a significant cost item when compared to the initial construction costs, or compared to such cost items as long term maintenance due to malicious mischief, citizen peace of mind, community pride, longer useful life of the facility, etc.

C. Related Programs and Growth Potential

If the sonic personal alarm proves to be effective in the context of urban dwelling security, the Subpanel believes that a coded radio version should be evaluated on city streets as a deterrent to street crime. Since the false alarm problem would be greater in view of the larger population of users, such a device could be individually coded so that activation automatically identifies the legal owner. In this case, the alarm device could be registered when it is distributed, and laws enacted imposing appropriate penalties for intentional or unintentional misuse.

To meet this city street requirement, individuals would be equipped with small short-range radio transmitters which may be packaged in the shape of ball point pens, shirt-pocket transistor radios, or other devices. When in need of police assistance, the transmitter is manually triggered which causes a unique frequency signal, including personal identification, to be generated and transmitted. Special receivers/relays, located in every city block, pick up the signals and transmit alarms to a central control point. At this facility, the alarms are processed and interpreted; and aid is dispatched to the location of the receiver/relay in the same manner that fire apparatus converge on the fire call box location. Once in the vicinity, the police can use direction finding equipment to home-in on the active radio transmitter should this prove necessary.

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Subpanel on Crime Prevention: Peter C. Goldmark (chairman), Robert J. Potter, William J. Kanz (advisor), Thomas G. Newman, Jr. and John J. O'Neill (staff).

AUTOMATIC LOCATION IDENTIFICATION (ALI)

I. Objective

The objective of this project is to study and implement Automatic Location Identification (ALI) which is a conceptual system that would provide emergency operating centers (EOC) with the means to identify the address of the telephone being used to call the EOC. Through call routing, this system would make it practicable for many municipalities to adopt the single emergency number (911), and ALI information would permit any EOC to respond more rapidly and accurately to emergency calls.

II. Project Outline

A. Background and Scope

To determine the feasibility of implementing ALI and to obtain the full benefits of an integrated 911/ALI system, two coordinated and parallel approaches are recommended by the Crime Prevention Subpanel, namely:

1) A telephone industry effort to provide for the planning, evaluation, and implementation of the necessary telephone plant functions and equipment associated with ALI, and

2) One or more municipal efforts to provide the planning, evaluation, and implementation for the most efficient use of the ALI system and the additional information which can be added to the incoming emergency calls incorporating ALI features.

These two study efforts should lead to the implementation of 911/ALI systems in one or two urban areas.

The municipal EOC's need for ALI may be summarized as follows:

- In many cities the jurisdictional boundaries of the emergency responding forces do not coincide with telephone exchange boundaries. With proper ALI implementation, calls could be routed automatically to the proper EOC, and it becomes feasible to implement a single emergency number (911) in these areas.

- Within a given EOC jurisdiction, there are often multiple responding forces with the same function; for example, multiple ambulance services, volunteer fire departments, rescue squads, etc. With ALI, address information is available for selecting, either manually or automatically, the responding agency with proper jurisdiction.

- By providing correct address information rapidly, ALI should reduce the total time for the EOC to respond to emergency calls.

- ALI should decrease errors and forestall time-consuming complications associated with repeated verbal transfer of information, foreign accents, caller's lack of knowledge of his precise location, etc.

- ALI has the potential for discouraging crank calls, intentional false alarms, bomb scares, and threats by helping to identify the location of the caller.

Jurisdictional Boundary Problem

With regard to the first point mentioned above, the following examples indicate the type of jurisdictional obstacles to implementing a single emergency number (911) in many cities.

The Washington, D.C. metropolitan area includes two states and the District of Columbia. Each state has multiple counties contiguous with the borders of the District. Each of these counties has an autonomous political body governing it, while the District has both a local and federal governmental structure. The telephone exchange boundaries which developed independently of these political boundaries do not necessarily coincide with these. Because of this overlapping, a citizen telephoning an EOC has the burden of first identifying the political jurisdiction in which he is located and then choosing from a list of emergency numbers the correct one for that jurisdiction. With an ALI system, it is practicable to implement a single emergency number, and the citizen dialing this number in an emergency would be assured of reaching the appropriate responding agency.

A second type of jurisdictional problem often encountered is exemplified by St. Louis, which is a relatively large metropolitan area within which there are more than 20 semi-independent EOC's. Each of these has its own jurisdictional boundaries. Without ALI, it is practically impossible to implement and obtain the advantages of the single emergency number.

Incidentally, the City of New York exemplifies the most straightforward jurisdictional situation in which there is complete coincidence of the boundaries of the police emergency service and of the telephone exchanges.

From the above discussion it is apparent that one function that should be performed by the telephone company as part of an ALI system is call-routing, that is, the identification of the emergency call destination based on the geographic location of the calling telephone. It is also apparent that the telephone industry and the municipal governments would need to coordinate their efforts to achieve the rapid development and implementation of ALI systems that would be most useful in overcoming the various types of jurisdictional problems.

Intrajurisdictional Boundaries

With regard to the second point mentioned in the section on Objectives, an ALI system would help resolve certain intra-jurisdictional problems. For instance, within a single EOC jurisdiction, there are probably several different emergency services (e.g., police, fire, ambulance, etc.), and in some cases more than one agency performing the same function (e.g., 3 fire houses). It is evident that with ALI data on the incoming emergency calls, the EOC could select the correct intra-jurisdictional force.

Call Handling at the EOC

The Subpanel was anxious to ascertain the time that could be saved and the complications that could be avoided if address information were automatically displayed for an EOC telephone operator. Thus, through the cooperation of the New York City Police Department, 600 calls received by the Department's 911 EOC were analyzed.* As noted earlier, in New York City the telephone exchanges and the jurisdictions of the emergency responding force are identical. Also there is a single overall dispatching organization for the police and fire departments. Thus, if a need for ALI can be demonstrated in this situation, any EOC area that does not have these two organizational problems solved would have a greater need for ALI.

Of the 600 calls analyzed, 282 were emergency calls, and of these 186 were from callers who were located at the place of the emergency. Thus, for 66 per cent of the emergency calls

*Analysis conducted by the Crime Prevention Subpanel in cooperation with the New York City Police Department

the telephone location was identical to the incident location. One can assume that in these cases, nearly all of the time spent in requesting and correctly recording the caller's location could be saved (approximately 15 seconds) if ALI were available.

A question was included in the survey to ascertain the number of cases in which ALI would have saved considerably more than 15 seconds. It was determined that 18 per cent of the 282 emergency calls fell into this category. This would amount to nearly a half million calls per year in New York City.

B. Implementation Details

1) Milestones

Two study programs are proposed: one by the telephone industry and the other by a municipality. It is important that the two studies proceed concurrently and be fully coordinated.

Assuming that the study findings are favorable the Crime Prevention Subpanel recommends the near term implementation of single emergency number (911) centers incorporating automatic number and location identification features in two urban areas. This implementation effort should be supported and funded by the Department of Justice and based on the previous studies.

A planning and guidance board or task force should be set up to monitor the project during the critical initial periods. The Subpanel would be pleased to set up such a task force if specifically requested.

2) Implementing Organizations

Through the encouragement of the Crime Prevention Subpanel, the Bell Laboratories of the American Telephone and Telegraph Company undertook to identify a generic solution to the 911/ALI question. This long range and highly flexible approach will provide a significant input toward the general solution. This basic approach includes the planning for and evaluation of:

a) The provision to the 911 service bureau of the calling telephone number for any call directed to that bureau.

b) Arrangements to convert calling telephone numbers to the listed directory name and street addresses. Such arrangements would include procedures to incorporate recent changes resulting from the installation and removal of telephone stations.

c) An arrangement which will permit a 911 telephone call to be routed to one of several 911 service bureaus in a metropolitan area. The determinant of the call destination will be the geographic location of the calling telephone.

It should be noted that there are problems associated with PBX and multiple party telephone numbers that are not being addressed by this Bell Laboratory study and evaluation. The Crime Prevention Subpanel recommends that additional effort be made in this area also.

The Crime Prevention Subpanel is pleased to learn of the independent telephone company efforts in this same area. For example, initial efforts for providing a 24-county area of Nebraska with 911/ALI features are being coordinated by the Mid-America Research Corporation.

The independent telephone company efforts should be guided by the approaches and objectives delineated above to ensure a fully integrated and nationally compatible 911/ALI system that can be implemented at the earliest possible date.

3) Location

An aspect of this project is the implementation of a 911/ALI system in two cities. It is suggested that one of these cities be within the Bell Telephone System's jurisdiction and the other within an independent jurisdiction. To assess fully the benefits of 911/ALI, it is recommended that the test sites have inter- and intra-jurisdictional boundary problems which have until now made the establishment of a single emergency number impracticable.

4) Evaluation

The criteria by which to evaluate ALI would be developed as part of this study and implementation project.

5) Cost

The Bell Telephone Laboratories of the American Telephone and Telegraph Company have undertaken the study of ALI, and an estimate of the implementation cost should be forthcoming from this work. At this time, an amount of $350,000 over an 18-month period should be provided to one or two municipalities for a system analysis and evaluation of how best to use the ALI (name, address, and location) information and how to integrate this information with their existing dispatch procedures and data resources.

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Subpanel on Crime Prevention: Peter C. Goldmark (chairman), Robert J. Potter, William J. Kanz (advisor), Thomas G. Newman, Jr. and John J. O'Neill (staff).

MUNICIPAL COMMAND CENTER

I. Objective

The purpose of this pilot project is to develop and activate a municipal command center which could operate 24 hours a day, seven days a week for resources management by coordinating information from all major segments of city services such as police, fire, civil defense, energy utilities, sanitation, and other essential resources, and would serve as a municipal command center during a serious emergency. Riots, earthquakes, major fires, snowstorms, hurricanes, enemy attacks, etc. are examples of such emergencies.

Furthermore, the coordination of such information for the use of the municipal decision maker has a strong preventive aspect. The gathering and assimilation of this information would enable the city authorities to recognize trends toward emergency situations so that action to avert an emergency could be taken, not merely corrective action following the emergency event.

II. Project Outline

A. Urban Need

The municipal decision maker has, as his primary responsibility, the management of all municipal resources so that the citizens benefit by the best cost/effective service possible. Decision makers are in need of 24 hours a day, seven days each week, communication centers responsive to their direction. The delivery of municipal services to the citizen now requires that citizen needs be served under the closest personal influence of the decision maker. Municipalities must build a communication system into a center which can provide the decision maker, the municipal staff personnel, and the citizen direct access with each other during normal or emergency operations.

Since most, if not all, cities already have extensive communications facilities serving these and other public services segments, the command center serves primarily a a management function, using existing systems to complete assigned tasks. This center then serves as an information gathering, decision making, and resource allocation center. It is a location where top city officials can assemble to receive the latest data and act on that information in the most efficient manner.

B. Pilot Program Description

The pilot program will have as its primary end result an operating municipal command center. The program will include several major tasks which encompass preliminary design studies, system design, implementation, operational test, evaluation, and agencies' expansion activities. Implementation of the pilot system will be limited to one location. The services to be provided by the center will be as follows:

- To support the decision maker with a data system which describes, in real time, the delivery of municipal services to the citizens.

- To provide the municipal staff with information about department operations and resources.

- To provide the citizen 24-hour-a-day emergency communication with essential municipal resources.

The municipal command center must have multipaths of inbound and outbound communications including, but certainly not limited to, telephone, teletype, two-way radio of all services, closed circuit television, public broadcast and television, and, perhaps, even the wire services. Organizing and assembling this information into a computer memory to be available when needed will be a major task in the development of such a center. The details are far beyond the scope of this brief outline. Suffice it to say, the system must have available the information considered necessary to deal with the type of emergencies that could occur.

A second major task is one of establishing a system for supplying information on the available resources, i.e., police cars, ambulances, fire trucks, bomb squads, water, gas, and electric utility vehicles, etc. In addition, transportation resources, buses and taxicabs should be a part of the information available to key city officials during an emergency. The technology of the near future will permit automatic vehicle identification and location and this can update the resource memory in a computer.

Neither of these two tasks will improve what now exists if the operational aspect is not considered as the most vital element.

It is relatively easy to engineer, design, and develop a system or system of systems to perform the aspects of information gathering and resource location and status. The real job is to make it work.

Anyone familiar with an Apollo moon shot would, perhaps, visualize a large room with many men stationed at communications consoles; each console equipped with a visual display with all necessary and required detail available to him in a split second. Each man has a headset to keep him in constant communications with the mission control manager so that every man in this room and those around the world become a part of a highly tuned professional team.

There is nothing wrong with this concept; we know it works -- when that team trains and trains and trains. These men have but one purpose in life, and that is -- The Mission. They know a rocket will thrust a space craft toward the moon, the space craft will perform certain maneuvers, perhaps land on the moon, take off again, return to earth, re-enter and land. Not simple, but they know about what to expect.

Consider now the municipal command center. Is it the same? The answer is yes and no -- the management of many men at many locations becomes involved and generates a peculiar family of problems. Most of these problems will be political, social, and organizational, and they are not simple. In an all-out emergency is there a special delegation of responsibility to any city departments? If so, when? Is this in addition to or in lieu of the regular chain of command? Thus, there is the very important and difficult task of establishing the human system to be used in the emergency.

Next, what about the emergency? Do we know what is going to happen, as in the space shot? The answer is a firm NO! The nature of all emergencies cannot be predicted. As noted in the opening paragraphs -- it can include a wide variety of disastrous situations, and each would require a different mix of the application of resources for most effective reaction.

And, to complicate the discussion even further, do these men operate these command center consoles as a team every day? Probably not, and no city could afford to have a fully manned, totally trained Command Center team standing by in case there is an all-out emergency. In fact, such a system used only occasionally would fail during an emergency, probably being less efficient than the separate systems operating independently with existing personnel.

To work, therefore, the first major step would be an acceptance on the part of the planners that the emergency system would most importantly be the same as the routine system used on a day-in day-out basis. It will mean that,

perhaps, all services relocate their individual control centers to one address, or in lieu of that, provide substantial communication paths to the municipal headquarters (as in a remote station in the Apollo Space System).

Once this major step is taken, the design of a center would concentrate on a system of organizing the communications flow to and from a central commander-in-chief during the emergency. Note that because the same people are operating the same electronics during the emergency, as they do on a daily basis, it will minimize confusion and panic.

We would visualize a glassed-in soundproof suite of rooms in back of a large room with the individual system control consoles. It is to these command offices that all of the vital incoming information is available, and can be instantly called up from a computer memory and shown on one of several color visual displays.

Conference rooms equipped with telephone conference systems will be available. Because the nature of an emergency might prevent a key individual, such as the mayor, from reaching the site at once, the planners may find it prudent to provide a video-audio link to his suite of offices so that he could direct operations from there instantly.

Observation rooms for the news media should be provided. This will allow the press to receive up-to-the-minute information for public dissemination, but will prevent interruption of key personnel by over enthusiastic reporters. Direct video and audio feed to the radio and TV broadcast stations let the broadcast stations feed the networks.

In summary, the real heart of the municipal command center is quite simple in nature; it is basically a system for gathering information on conditions and resources and providing an environment for key officials to absorb the situation and, in a calm atmosphere, make decisions based on the best available data. Then, they can allocate the available resources, and, finally, keep the public informed to prevent panic through proper rumor control.

1) Milestones

The tasks to be accomplished during the pilot program are:

a) Design Study -- This task will select information and interfaces to augment the perspective of decision makers, agencies, and individuals involved with the command of municipal resources.

b) System Design -- The hardware system configuration will be determined and equipment procured. Software will be developed and tests and evaluation procedures specified. An operator training program will be developed.

c) System implementation equipment will be installed, tested and debugged. Operators will be trained.

d) Operational Test -- The system will be placed into service with trained operators. Performance will be monitored. Software may be modified to incorporate improvements or expanded services determined after design study.

e) Evaluation -- The system will be evaluated according to criteria developed as a part of the project.

f) Center Expansion -- Improvements in the system and expansions of the center capabilities will be studied. In cases requiring only software or minimal hardware changes, these might be incorporated during the test program.

2) Program Time Schedule

The duration of the pilot program is anticipated to be about 30 months. The duration of each task is estimated below. These are serial times on the critical path and hence project milestones. Some efforts including all of those related to Task Six are conducted in parallel.

Task 1 -- 6 months

Task 2 -- 9 months

Task 3 -- 3 months

Task 4 -- 9 months

Task 5 -- 3 months

Task 6 -- Slack Path

Total -- 30 months

3) Location

The project should be located in a major urban area. The urban area selected should have a history of commercial, residential and government interaction problems. Housing the center in an existing facility is highly desirable.

4) Evaluation Procedures

A major task of the project will be to develop evaluation criteria. The most valuable evaluators and criteria will come from an analysis of local government agencies and the decision makers before and after the project is completed.

The actual benefit of this project is an improved decision-making process for all concerned.

A secondary benefit to the municipality is that related systems costs may be reduced in the future when primary and sub-systems are brought together under one telecommunications umbrella for coordinated resource management operations.

5) Costs

The cost of a pilot project will depend upon the degree to which the city wishes to implement the municipal command center concept. The operating principles of the center could probably be demonstrated through the minimum cost of establishing separate, dedicated communications lines between the mayor's office and the offices of the heads of each of the city's departments. However, as much is to be gained through face-to-face coordination, the minimum implementation should be considered as a headquarters room with desk space for the mayor and the heads of all of the departments with the dedicated communications lines to the individual department control centers.

A complete installation for a city of 700,000 population would cost something of the order of $1.5 million, not including the office space. It would include a complete digital computer capability, software for all operations, training, security, etc. For a city of 150,000 population, a similar system would cost of the order of $750,000. In a closely managed project, a city of 100,000 population might be equipped with an adequate center for about $500,000, not including the office space.

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Subpanel on Administration and Emergency Services: Daniel E. Noble (chairman), George R. Rodericks, and Richard C. Hopkins (staff).

General

TECHNOLOGY HANDBOOK FOR URBAN CABLE PLANNING AND FRANCHISING

I. Objective

To provide an authoritative broadband communications systems handbook for municipal governments and regional planning authorities.

II. Background and Scope

The introduction of a new technology into any area of urban activity presents an additional management challenge to the municipal government. Recommendations and decisions concerning the use of new technology are often required of municipal employees ill-equipped by background or training to make these recommendations or decisions. There is rarely time or money to be spent to inform the employees even in the most important and far reaching areas of municipal government activity.

Although such comments can apply to most of the new technology in this report, urban cable systems represent such a fast spreading and important telecommunication system, which will interact with so many elements of the urban community in both the near and long term, that the Committee recommends a federally sponsored project aimed at introducing the nation's urban leaders to the full scope of technical considerations in urban cable planning and franchising. Information on typical urban requirements for broadband cable networks and a guide for determining network configuration for meeting specific requirements should be provided.

For example, if planned and franchised properly, a single one-way coaxial cable distribution system can readily be implemented to provide twelve TV channels, and then later be modified to incorporate limited two-way features with frequency crossover filters and appropriate amplifiers for each direction. Multiple cable distribution systems can provide more expanded two-way systems. Urban areas need background information on the range of such alternatives, as well as the functional near and long term service potentials and economics of each alternative.

Potential uses for well-designed urban Broadband Communications Networks (BCN) include applications in such diverse areas as transportation (e.g., mobile communications

and automatic vehicle monitoring), education (e.g., two-way educational capability), welfare, courts, public safety, law enforcement, commerce, postal distribution, libraries, and emergency health delivery. The implications of ignoring key system parameters should be suggested by indicating the degree of jeopardization to future developments of BCN's. There should be discussion and quantitative data as to how the BCN may provide municipal cost savings, which may actually be greater than the income levels provided by franchise fees.

The overall intent of this project is to provide an authoritative BCN handbook or primer for municipal governments and regional planning authorities. The general potentials of a BCN system for each of the major municipal functions would be detailed to a level necessary to allow a municipal decision maker to understand the principal technical alternatives and their costs before entering into franchises.

Interconnection requirements for neighboring municipal BCN systems and for national interconnection via domestic satellites should be delineated. It is quite important that BCN planning advice for urban clusters or metropolitan regions be instituted. Independent franchises associated with independent contiguous municipalities must provide the opportunity for interfacing neighboring systems, whereby community colleges, or regional agencies such as transportation, recreation and public safety, are able to have simultaneous access to public service channels. For example, in the Peoria, Illinois metropolitan area, the three major contiguous municipalities have enacted a resolution which establishes minimum public service channel capacity (50%), and which requires simultaneous total metropolitan access as well as independent local origination capability.

The report from this project would not be a complete do-it-yourself manual for design and franchise, but rather would be directed toward informing city officials sufficiently well to allow for effective discussions with others so that they can then seek specific technical and legal advice and be guided to expert independent engineering consulting firms in various telecommunications fields; the report can include a directory of those consultants who wish to be so listed.

III. Implementation Details

The study should be addressed in detail to:

- Definition of normal and off-normal performance requirements, taking into account FCC regulations or any other regulations governing safety, interference, cross-talk, and user plant. Statements based on hypothetical reference configurations relating to typical urban and suburban demographics are preferred.

- General information regarding choices to be made of appropriate equipment and facilities including cost, comparative effectiveness of alternatives, and criteria for making choices.

- Means for network control, maintenance and operation in the normal and off-normal conditions.

A. Contents of the Handbook

The contents should at least include:

1) Description of present and future systems, including (a) technical, (b) economic, and (c) programming aspects.

2) Annotated bibliography on further readings.

3) FCC and other regulations.

4) Contracts and franchises.

5) Directory of independent consultants.

6) Directory of present systems, including franchises, equipment suppliers, etc.

The discussion of contracts and franchises would emphasize technical considerations, though these are not readily separable from the financial and legal aspects. One or more sample franchises could be provided, together with a check list of major elements to be included, such as:

1) Minimum initial services.

2) Provision for and/or requirement for new technical improvements and services.

3) Minimum technical performance standards for each class of service.

4) Formula for public channel allocation.

5) Requirements for local programming, including responsibility or immunity of cable operator for control of programs.

6) Aerial vs. underground installation, including coordination with telephone, subway, and power installations.

7) Access problems in multi-tenant buildings.

a) Tenants' rights to cable connection.

b) Operators' right of access for service.

8) Installation progress: reporting, review and expediting.

9) Duration and exclusivity of franchises.

10) Ethical standards in franchising.

B. Implementing Organization

In order for the report to be as acceptable as possible, it should be issued under the imprint of an appropriate, non commercial organization, such as the National Academy of Engineering or the National League of Cities. The project should be adequately financed by an appropriate federal agency such as NSF or HUD. The actual compiling of the report could be done by appropriate individual staff and consultants, suggested by the NAE, if the NAE is not the contractor.

C. Time Schedule and Costs

Because of the fast pace of cable TV growth, the handbook should be made available to the cities as soon as possible. On the other hand, as a writing task, not more than one or two persons can function effectively in its preparation. Gathering and checking of information is important, too, so that the handbook would be accurate on present conditions, and neither oversell nor undersell future possibilities. Visits to present systems and interviews with many people would be necessary. It is estimated that one to two man-years of professional staff would be appropriate.

Professional Staff		$20,000 - 35,000
Secretarial		6,000 - 10,000
Travel		2,000 - 5,000
Miscellaneous and overhead		20,000 - 40,000
	Total:	$48,000 - 90,000

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Cable TV Task Force:
Joseph M. Pettit (chairman), Donald A. Dunn (chairman), Philip Weinberg (consultant), and John J. O'Neill (staff).

General

ANALYSIS OF REQUIREMENTS FOR AUTOMATIC VEHICLE MONITORING

I. Objective

To determine the degree to which a single Automatic Vehicle Monitoring (AVM) system can be made to serve the needs of a number of telecommunication systems used for different urban functions. It would appear that many urban functions that serve public interests, both those operated by the local government, such as police, and those operated privately, such as taxicabs, could be improved by use of AVM. However, the cost of a single purpose AVM system would be prohibitive for some of these users, and it would be economically wasteful to install more than one AVM system in a given area if one could provide the service needed.

II. Outline

A. Scope

This project would be a study of the AVM requirements of all potential public service users.

Potential users would be identified, and a detailed study of the operations of each significant class of such users would be made. The study would determine the extent to which these operations could be improved by AVM, the economic benefit to be derived and the functional requirements of the AVM system best suited to them. Analysis of the data of this study would be made to determine groupings of urban functions that form logical operations to share elements of a common AVM system and the AVM requirements of each group, such as accuracy of location, frequency of location sensing, and vehicle nearest a given location.

B. Implementation Details

1) Milestones

a) Project definition and planning.

b) Classification of urban users employing vehicles in public services.

c) Selection of a typical user in each class for detailed study of his operations, to determine his

requirements of AVM, the benefits AVM would provide in terms of efficiency of operation and improvement of service to the public, the value of AVM to this class of user, and the functional distinctions in his use of AVM. (By "value of AVM to user" is meant that initial and operating costs could be justified economically as being offset by savings in operating costs.)

d) Analysis of results from studies of these various users to determine what users would benefit significantly by use of AVM; how these users could be grouped together to use a single AVM system, and the functional requirements of such an AVM system. The functional requirements would include the precision of location necessary, the frequency with which updating of location is required, the random identification of vehicle nearest a given location, and reliability needed.

e) Formulation of, and recommendations for a pilot project that will adequately demonstrate the effectiveness of a shared AVM system.

2) Implementing Organizations

Such a study can well be performed by a non-profit research organization with cooperation from local government agencies, user associations, individual users and the telecommunications industry.

3) Time

Duration of the project would be six months. While the work can be divided into distinct phases, all have to be done to achieve significant results.

4) Location

Since the results would be of country-wide application, data would be gathered from a number of cities.

5) Evaluation Process

No evaluation can be made until the Analysis milestone has been completed. At this point, determination will be made as to whether significant shared use of AVM is indicated. If it is not, there would be no need to develop a plan for a pilot project.

6) Cost

Total Project: $100,000.

7) Method of Amortization - Source of Funds

Since this is a study project of general interest, it should be supported by federal funding, without amortization.

C. Related Programs

This program is of major importance to all programs involving communications for purposes of control and command of moving vehicles and, if successful, can point the way to providing shared use of AVM to systems that otherwise could not afford it.

D. Growth Potential

The results of the proposed study would be applicable to many cities throughout the country.

Analysis of Requirements for Automatic Vehicle Monitoring
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Subpanel on Transportation: Richard P. Gifford (chairman), Ernst Weber, George L. DeMent (deceased), Hugh H. Davids (adviser), Ralph W. Tracy (adviser), Richard C. Hopkins (staff), and John J. O'Neill (staff).

General

RADIO FREQUENCY PROPAGATION IN URBAN ENVIRONMENTS

I. Objective

To provide a data bank on urban radio frequency for the designers of urban communications systems.

II. Project Outline

A. Background and Scope

The overall question of urban communication system design for mobile urban use is not easily answered when using the available urban propagation data. This is true when considering urban communication system designs for mobile transportation systems (either fixed or random routing), public safety systems, or municipal-wide emergency communication networks. In addition, each of these urban communication systems must operate within the rules and regulations set up by the FCC to ensure orderly growth and mutual compatibility. The task force recognizes the lack of a sufficient urban propagation data bank for the designers of these urban communication systems. To satisfy this basic need the task force recommends an Urban Radio Frequency Propagation Project. To provide some additional insight into the scope of this project recommendation, a more detailed recommendation in the field of public safety is delineated below. It will be understood that similar projects are recommended, in conjunction with the FCC, in each of the other mobile urban communication system areas.

It has come to the attention of the task force that the public safety and law enforcement areas of urban municipal governments throughout the United States have unique mobile communications data requirements. This is particularly true when considering the great variety of man-made structures found in a typical urban area, coupled with the increasing need of public safety officers to patrol these structures on a routine basis. The lack of this data represents a specific technical problem that the task force recommends be addressed by an urban radio frequency propagation study project.

For example, questions concerning the most efficient propagation for intra-building and/or single and multi-leveled intrasubway mobile use are not easily answered with existing data. Inter-building and inter-subway mobile communications requirements of public safety raise further questions.

Additionally, means for passively locating an injured or trapped officer in any of these structures requires still additional propagation data not currently available to system designers.

The task force therefore recommends that urban radio frequency propagation studies, field measurements, and tests be sponsored and funded by the Department of Justice to fully satisfy the complete spectrum of public safety urban propagation data requirements. This data should be in appropriate form to establish a set of urban propagation engineering tables for system designers, and/or in a form for later computer manipulation. These DOJ efforts should fully recognize the current and projected FCC public safety frequency allocations, as well as the FCC's boundaries on modulation modes within these frequency allocations. A panoramic effort involving FCC restricted frequencies and/or FCC restricted modulation modes is not recommended.

B. Implementation Details

1) Implementing Organization

To get effective results most quickly, a special task force should be set up by the Land Mobile Engineering Committee in the Electronic Industries Association (EIA) to work with the Department of Justice and representatives of law enforcement agencies, with a chosen government or private research organization providing overall coordination.

2) Time

The overall duration of the study project should be about 1 year.

3) Cost

For planning purposes costs are estimated at $250,000.

C. Related Programs

The work proposed in this study project would complement studies currently under way at 900 MHz through EIA/FCC cooperation.

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Radio Frequency Task Force:
Richard P. Gifford (chairman), Kenneth G. McKay, Daniel E. Noble, and John J. O'Neill (staff).

Special Recommendations

In keeping with the objectives of the study, the Subpanel on Education, Training, Recreation and Culture has identified several non-technical barriers to the effective use of telecommunications technology. Among those are several which relate directly to the use of the television media (both broadcast and cable) to provide useful urban services.

I. Training of Minority Communications Professionals

The effective implementation of urban telecommunications technology must take account of the fact that success in many instances will depend upon social acceptance. Active participation by minority population groups should be sought and developed.

Such groups are an important element in the urban environment, yet they are disproportionately unrepresented in the communications and information fields.

The subpanel recommends that appropriate organizations foster greater participation of minority groups in the legal and other professional aspects of the communications field. To illustrate the problem, in the legal field there are only two minority communications lawyers out of a total of three hundred fifty. While it does not follow that greater minority representation will assure social acceptance, it is reasonable to assume that minority participation increases the probability that important social considerations will not be overlooked.

Among the organizations most qualified to assess the problems peculiar to communications law and best able to recommend solutions are:

a) American Bar Association

b) Federal Communications Bar Association

c) Law schools and colleges

d) Federal Communications Commission

e) Office of Economic Opportunity

The preparation of other minority professionals such as writers, editors, directors, producers, engineers and technical specialists, can best be determined by such organizations as:

a) National Association of Broadcasters

b) National Cable Television Association

c) National Association of Educational Broadcasters

d) Institutions of higher learning

e) Corporation for Public Broadcasting

f) Federal Communications Commission

g) Office of Economic Opportunity

While significant personnel inputs at the higher professional levels may require a longer than desirable time to achieve, many of the manpower requirements in various phases of the industry can be satisfied early by creation of intensive programs.

II. Programming for Non-Commercial Television Channels

Unless effective low-cost programming techniques are developed, the potential of cable television to provide low-cost channel capacity will have little impact. Along with the deployment of advanced cable systems must come an extensive effort to generate program materials which are beneficial and valuable to the community.

The Committee suggests two approaches to this problem which could be incorporated into a demonstration project. First, an attempt should be made to influence existing broadcasters in the city in which this project is carried out to carry more programs oriented to the needs of the various communities in their area. An effective precedent for this type of action exists in Atlanta where a Community Coalition on Broadcasting (CCB) was able to get commitments from 23 out of 28 local radio and TV stations to provide placement of minority group members in decision-making positions. All stations agreed to periodic meetings with a CCB committee and promised to expand public service announcements of interest to the minority community. A similar representative group from the disadvantaged community should be created in other cities and encouraged to work with new as well as existing sources of programs, including the cable TV operator. If a cable system has not yet been franchised in the area, the local CCB could serve an important function in obtaining a franchise favorable to the public interest.

The second approach to the development of new program sources is the direct one of financing programming projects within the local community and from outside sources. An example of the type of programs that might be developed is an Adult Sesame Street aimed at functionally illiterate adults. On a demonstration basis it would be possible to provide funds for this purpose from a federal or state agency. In the long term it would be possible to use funds generated by cable subscriptions in the city served. At the present time some cities divert 5 percent of the gross revenue of the cable system to general city funds. Part or all of this money could be used to support local public service programming. Under projects of this kind, a local community group should help decide what programming to develop. If successful, such a project could create community pressure to use local funds to continue the service when the demonstration was completed. In fact, an important measure of effectiveness of the project would be its ability to attract sufficient community support to allow it to continue.

Other local programming mechanisms oriented toward utilizing local talent and interest groups could be of great potential. Steps should be taken to explore the problems of community access to public service channels and to help stimulate the development of new programming concepts of this type.

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Subpanel on Education, Training, Recreation and Culture: Edward C. Jordan (chairman), Joseph M. Pettit, Donald A. Dunn (consultant), William Sharp (adviser), Philip Weinberg (consultant), Stanley A. Garlick (staff).

CHAPTER IV

THE CITIES OF THE FUTURE

Introduction

In the last ten thousand years little has changed in the physiological and behavioral characteristics of man. In contrast, science and technology have radically influenced our living pattern in the last 150 years. While there are a great many statistics that indicate the uncontrolled increase in the rate of change, a few typical examples are presented here.

Ten thousand years ago, in the entire world there were no more people than in Greater New York City today, about 10 million. Figure 1 shows how population increased in the last few hundred years. By the year 2000, the earth population will be about six billion (from the present 3½ billion) and, at the same rate of growth, in a hundred years it will be 24 billion.

A contributing factor to this growth is that life expectancy today is two and a half times what it was two centuries ago (infant mortality included) (Figure 2).

The vast majority of people in the most western countries, live under conditions of extreme population density and within the confines of cities and their suburbs. Man is physiologically and psychologically unprepared for the resultant stresses and strains.

In addition to the increasing rate of change, population density makes it difficult for man to cope with his environment. Among the major problems threatening urban existence are crime and pollution. Figures 3 and 4 show how crime and pollution increase in relation to city size.

This country is facing the question of survival within and outside of its cities. The problems of crime, pollution, poverty, traffic, etc. also exist in small cities, but they are manageable and will remain so, if proper planning takes place.

For these reasons, and to offset the trend toward high density urban living, a national effort should be launched to encourage growth in the smaller communities in the United States. If all the communities that presently have between

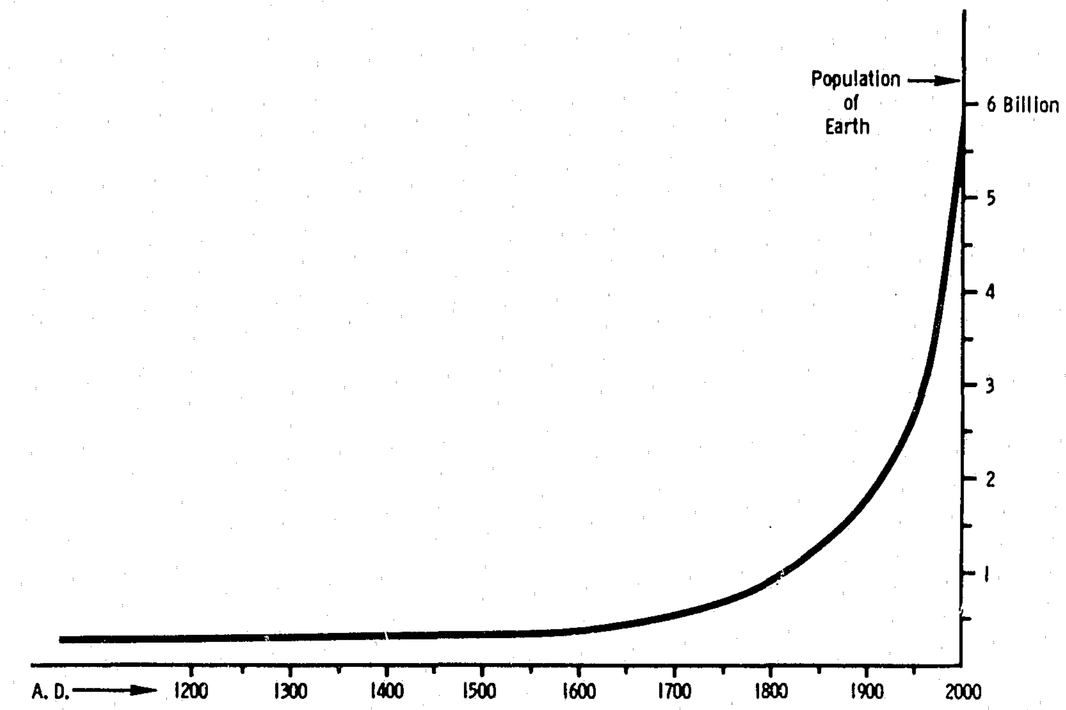

Figure 1

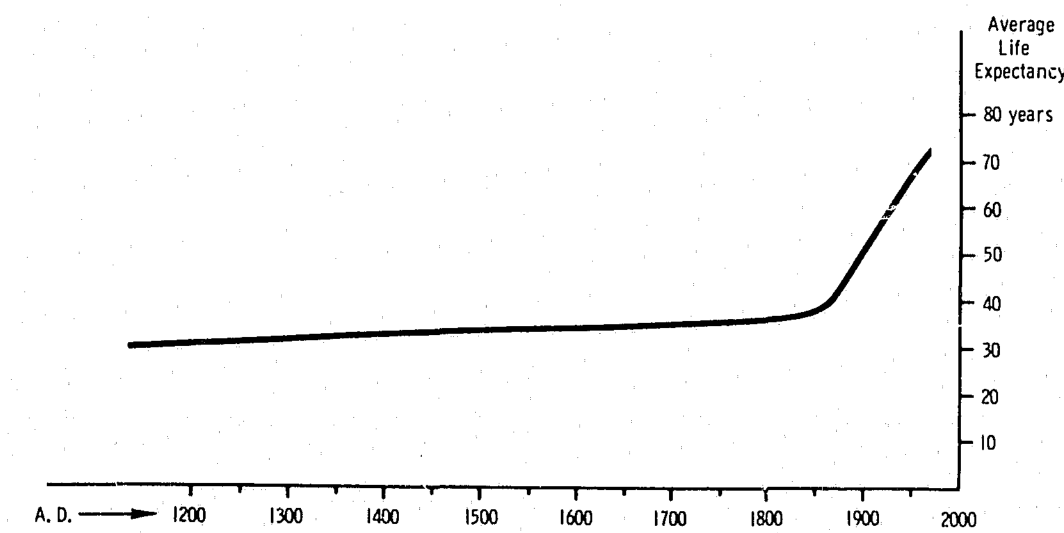

Figure 2

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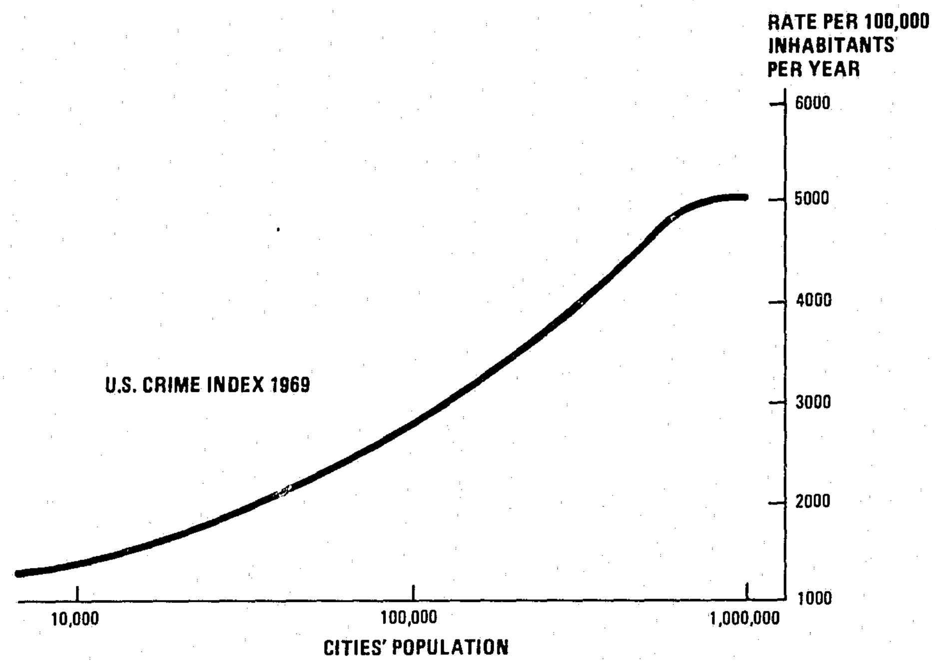
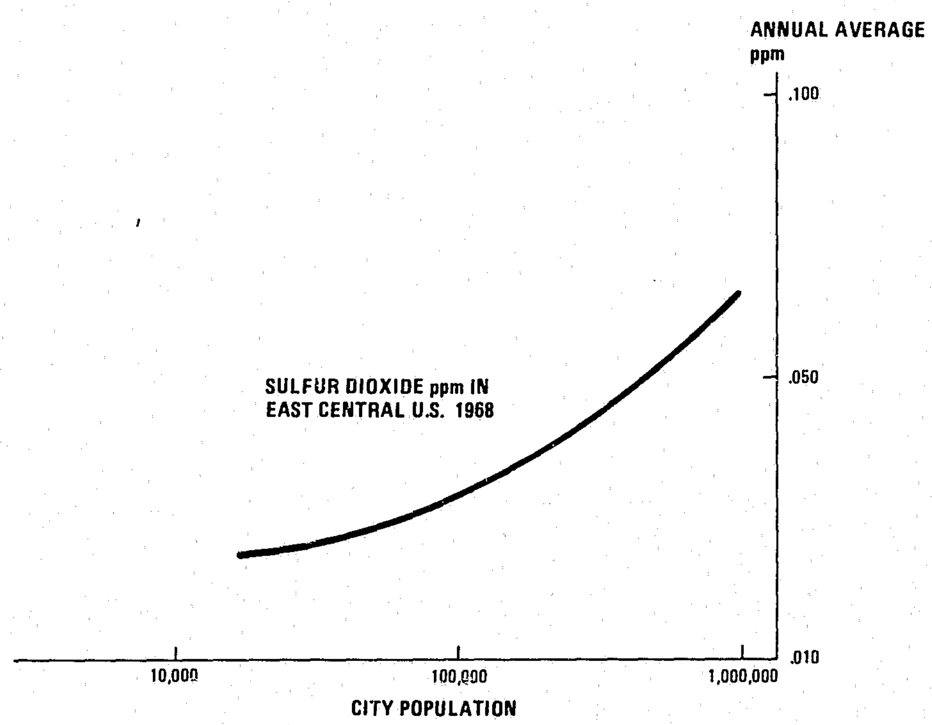


SOURCE: Uniform Crime Reports-1969 FBI

Figure 3



SOURCE: Unpublished material prepared by the Mitre Corp.

Figure 4

5,000 and 100,000 population grow at an average rate of 3½% per year, they could accommodate 100 million Americans over the next three decades. This total might comprise half of the additional 100 million Americans predicted for the year 2000, and 50 million urban dwellers who would prefer to live in the new rural environment.

To illustrate the dimensions of the overall task, the tabulation below shows one of the ways in which 100 million people could be distributed over the next 30 years among existing communities of 100,000 population or less. The average yearly population growth rate is given, as well as the average number of new jobs that would have to be created each year over the next 30 years. Of course, the creation of new towns will make the task easier.

POPULATION GROWTH MODEL FOR SMALL CITIES

City Size by Population	Number of Cities in 1960	Total Population in 1960	Additional Population Growth Required Over 30 Years		Uniform Yearly Population Growth Rate per cent	Yearly Population Growth Averaged Over 30 years	Additional jobs needed per year averaged over 30 years (family = 4 members)
			per cent	people			
50,000 to 100,000	201	14,000,000	50	7,000,000	1.5	1,100	275
25,000 to 50,000	432	15,000,000	200	30,000,000	3.75	2,310	577
10,000 to 25,000	1,134	17,500,000	200	35,000,000	3.75	1,030	260
5,000 to 10,000	1,394	9,780,000	290	28,000,000	4.75	670	168
	Total population accommodated over next 30 years			100,000,000			

Generally, smaller communities should be encouraged to grow more rapidly than larger ones, and first attention should be given to the communities which are in attractive rural environments and sufficiently distant from existing population concentrations to prevent possible fusion with these concentrations.

While many factors are part of a community's growth

process (natural resources, labor markets, utilities, land and air transportation systems, etc.), the major growth criteria are the influx of business, industrial and government operations. Expansion in these would require improvements in education, health care, and in the provision of cultural activities. New applications of communications technologies will be necessary to provide for almost all these major factors of community growth and well being.

The task is to provide the generations following us with a greatly improved quality of life. This will be possible if the majority of the people will live and work on the major portion of our land. At the same time that the demands made upon the urban environment will be lessened, life in rural America will be made more viable. Communications technology is the *sine qua non* in accomplishing this task.

Background and Needs

By the end of the century, unless countervailing plans and incentives are devised, it is predicted that three-fourths of the U. S. Population will live in twelve urban centers as shown in Figure 5. Over half of all Americans will be crowded into three major urban-suburban concentrations shown on the same map; namely:

The Boston-Washington region
The Chicago-Pittsburgh region
The San Francisco-San Diego region

Communications technology could play an important role in creating new and better settlement patterns and concurrently in alleviating some of the problems of existing cities.

A first step was tekan in 1968 when a Presidential Advisory Group on Telecommunications requested the National Academy of Engineering to establish a Committee on Telecommunications. As an outgrowth of this, the NAE Committee's Subpanel studying the use of communications technology to create better living patterns was combined with the Connecticut Research Commission's Committee on Communications Technology. The combined group is called the Joint Committee on "Cities of the Future".

It is the goal of the Joint Committee to investigate imaginative applications of communications technology to business, education, government, health care and cultural pursuits that might stimulate a full utilization of the

12 MAJOR URBAN REGIONS PROJECTED BY YEAR 2000

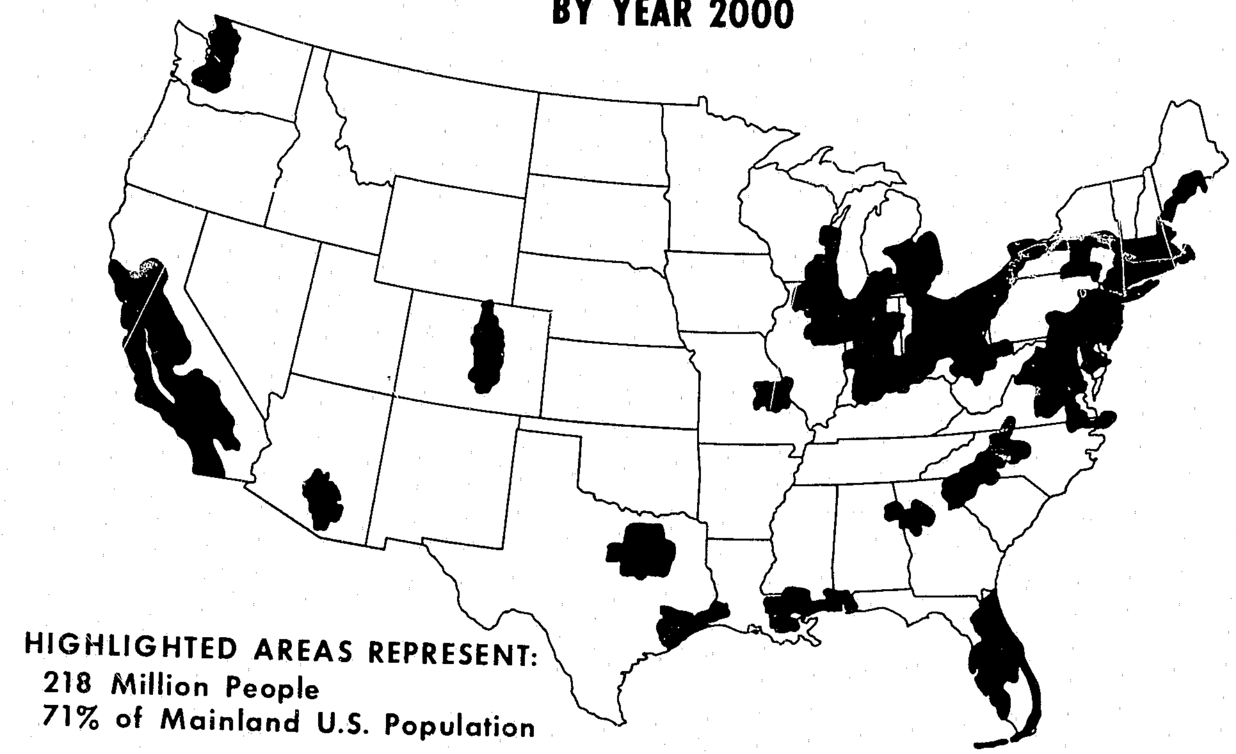


Figure 5

nation's land resources for living. Specifically, the Joint Committee feels that the inventions have already been made to permit the design of special communications systems which will allow these activities to be conducted more effectively in small communities scattered throughout the nation. It is important to stress that the intent is not to de-urbanize the United States, but to give the next 100 million Americans the option to live and work in an improved urban, or a new rural environment.*

Since people usually migrate to places which offer the best employment opportunities and living environment, and business and industry also seek areas where a suitable work force is available, two things must happen:

First, state and regional planning must pinpoint small communities according to the availability of space, utilities and other local services where business and population growth can be carefully planned to insure the desired quality of life. Satisfying local needs and aspirations are paramount considerations in the program.

Second, the operation of business, education, and government, as well as the means to provide for health care and culture must be analyzed. The objective is to apply the proper communications systems to these functions to permit business and government to move to attractive rural

*Among the recent Congressional Acts that bear upon the issues discussed here are:

The 1970 Agricultural Act, Title IV, Sec. 901(a): The Congress commits itself to a sound balance between rural and urban America. The Congress considers this balance so essential that the highest priority must be given to the revitalization and development of rural areas.

And, The Urban Growth and New Community Development Act of 1970, Title VII, Sec. 702(a): The Congress finds that the rapid growth of urban population and uneven expansion of urban development in the United States, together with a decline in farm population, slower growth in rural areas, and migration to the cities, has created an imbalance between the Nation's needs and resources and seriously threatens our physical environment, and that the economic and social development of the Nation, the proper conservation of our natural resources, and the achievement of satisfactory living standards depend upon the sound, orderly, and more balanced development of all areas of the Nation.

areas while maintaining effective interaction between their widely separated offices. At the same time, provision must be made for the development of cultural activities which are often considered absent in rural community life.*

The viability of this plan is enhanced by the continuing transition of the United States economy from a manufacturing to a service economy. It is the service sector -- finance, government, insurance, etc. -- which is expected to make the greatest use of telecommunications.

The problem of creating alternative living patterns through the application of communications technology has been the subject of a Connecticut Research Commission (CRC) study.

Connecticut is one of the country's most densely populated states where 75 percent of the people occupy 25 percent of the land. During the next 30 years the state's population will increase from 3 million to 5 million. If this takes place in the absence of adequate planning, the majority of Connecticut's inhabitants will live within the already crowded urban spine which is the shaded area in Figure 6.

The CRC Committee recommended that the feasibility of distributing business and industry to rural areas through provision of adequate electronic communications and transportation facilities be further explored by developing a pilot project in the northeastern sector of Connecticut. It was further recommended that the project include demonstrations of the potential uses of broadband communications links and terminal equipment, and that Federal and State Governments and industry be invited to participate in the CRC's program.

Because the task facing Connecticut is similar to that facing the nation, it seemed logical to combine the CRC Committee with the NAE Subpanel on the Cities of the Future. The Connecticut study was funded by the Connecticut Research Commission. The National Academy of Engineering Committee

*While communications technology can make it possible for business, industry, education, and government operations to function efficiently in rural areas, a determination of the best sites within a region for location of these operations would depend on a number of other factors such as land, water, and power resources, the nature of transportation networks, tax structure, availability of housing, zoning etc.

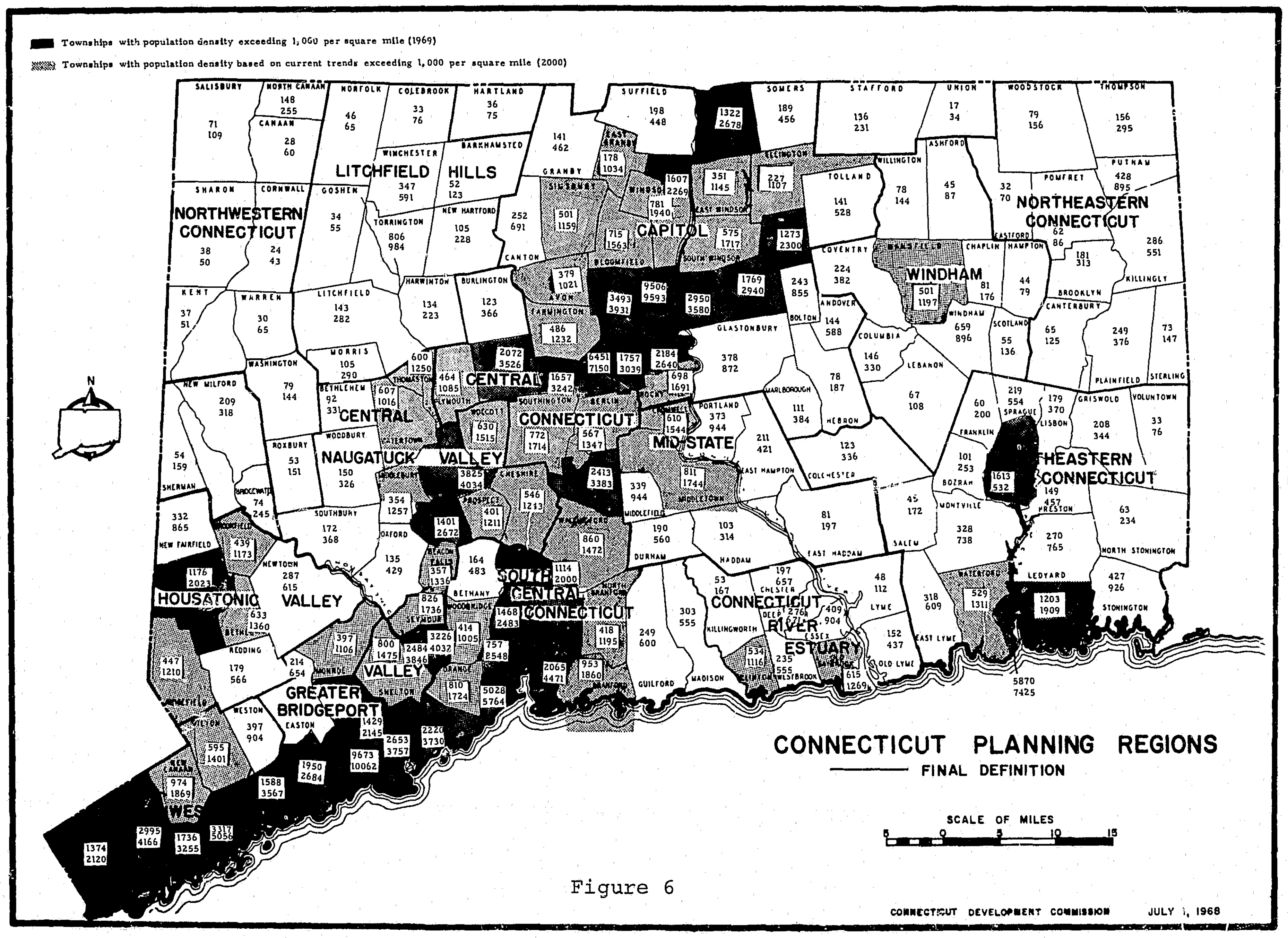

Townships with population density exceeding 1,000 per square mile (1969)
Townships with population density based on current trends exceeding 1,000 per square mile (2000)
LITCHFIELD HILLS
NORTHWESTERN CONNECTICUT
CAPITOL
WINDHAM
NORTHEASTERN CONNECTICUT
CENTRAL NAUGATUCK VALLEY
CENTRAL CONNECTICUT
MIDSTATE
SOUTHEASTERN CONNECTICUT
HOUSATONIC VALLEY
VALLEY
SOUTH CENTRAL CONNECTICUT
CONNECTICUT RIVER ESTUARY
GREATER BRIDGEPORT
CONNECTICUT PLANNING REGIONS
FINAL DEFINITION
SCALE OF MILES
N
CONNECTICUT DEVELOPMENT COMMISSION
JULY 1, 1968

Figure 6

on Telecommunications is supported by several Federal agencies under the leadership of the Department of Housing and Urban Development (HUD).

The Joint Committee's study reflects some of the ideas developed in England as the British sought a solution to their own high-density population problems. In 1944, the Abercrombie Plan for Greater London provided for the establishment of many new towns around London, past the so-called Green Belt.

The purpose of the plan was to relieve the concentration in Inner-London and to provide a better environment for living and working. Thirty-one new towns were built which were successful in attracting business and industry.

The British government concluded that the main factor deterring business and industrial decentralization was the reduced operating efficiency due to the absence of fully adequate communications facilities.

Another British study, by a group called the Joint Unit for Planning Research, has examined, in a series of thorough experiments, communications between widely separated operations.* They conclude that:

1) The ordinary telephone is highly effective for one-to-one communications, particularly where familiarity between participants is high, conflict is low, and subject matter is well defined.

2) The greatest value of a wideband network suitable for television or video-phone, will lie in its ability to handle a wide range of auxiliary services such as graphics display, rapid facsimile, computer and data access, conferencing, etc.

3) There will be large scale decentralization of employment from large metropolitan centers as the various person-to-person telecommunications systems improve.

4) The effect on the volume of business travel is likely to be negligible.

*Reid, Alex: "Report to the NAE Committee on Telecommunications," Communications Studies Group, Joint Unit for Planning Research, England.

Most importantly, the British study concluded that the chief effect of telecommunication developments will be to increase choices: the employee will be able to select the environment in which to live; the company or government operation will have a choice of areas in which to locate.

In pursuit of their ruralization plans the British are currently designing four broadband services -- a national data network, conference television, dedicated cable educational television for the London area, and household wired television.

In the United States a national effort to make greater use of the land for an improved quality of life requires smaller scale exploratory programs. To implement such an exploratory program in Connecticut, an interdisciplinary approach must be taken to satisfy simultaneously a number of conditions;

- Business, industry and government must find it beneficial to move into attractive rural areas away from urban/suburban complexes.
- Communications technology must provide the services which will enable business, industry and government to function efficiently as a result of such moves.
- Those small communities which desire to grow by adding business and governmental operations must undertake to plan for orderly expansion and carefully determine those limits which would guarantee a high quality of life.
- State and regional planning must be coordinated with town planning to assure that, in addition to the necessary communications systems, other necessary resources such as utilities, surface and air transportation, etc. are provided.
- A two-way broadband communications link and operating systems will be necessary for experimentation.

One can hypothesize that the communications systems which would interconnect new or enlarged rural communities and cities might consist of the following:

1) Incoming broadband cable or microwave circuits which connect the town's businesses, industry and government offices with their operations in other cities or countries. These are essentially dedicated point-to-point links.

2) Long-distance broadband circuits interconnecting the town's switched telephone and video-phone services with the corresponding switched services in other cities.

3) Common carrier broadband and narrow band services such as U.S. Postal Service, Western Union, and others for transmission of messages, printed material, data, etc. between towns and to other countries.

4) Incoming circuits for educational, cultural and recreational pursuits. These would be:

    a) radio and television broadcast circuits both for private networks and public broadcasting

    b) two-way broadband educational television circuits interconnecting a small local campus with the region's central university

    c) a broadband cable circuit as part of a national high-definition closed circuit television network bringing live Broadway, opera, concert and sports productions to theaters especially geared for such presentations.

Eventually a determination would have to be made of the types of communications networks that should interconnect the nation's communities and permit distribution of electronic signals within the communities. The findings of the exploratory program would bear upon this matter.

Pending determination of funding sources to continue its programs, the Joint Committee has initiated steps to plan for the interdisciplinary program:

- The participation and full support of the University of Connecticut at Storrs was obtained. The University could become the cultural and educational focal point for development in northeastern Connecticut.
- The Committee is establishing relationships with several business organizations who may expand their operations.
- Discussions are being held with state and regional planners to insure that their plans and the Joint

Committee's are fully coordinated. Specifically, Connecticut's Office of State Planning and the Windham Regional Planning Agency (Conn.) are reviewing the concepts of the Joint Committee's program. The University of Connecticut's main campus is in the Windham region (see Figure 7).

- Discussions with the Southern New England Telephone Company have been scheduled to determine the feasibility and cost of modifying the existing microwave link between the University of Connecticut and its Hartford branch, to provide the proposed broadband links. Other alternatives are being pursued.

It is recommended that other state and federal agencies take full advantage of the Connecticut model by cooperating in formulating the research and experimental programs. At present, the representatives of three Federal Government Departments and twelve governors' science advisors who are interested in developing similar programs within their own states are cooperating with the Joint Committee.

The participating states represent the major geographic, economic and demographic characteristics of the nation. They are:

Colorado	New Mexico
Georgia	Ohio
Illinois	Oregon
Missouri	Pennsylvania
Nebraska	Texas
New Hampshire	Wisconsin

The sparsely populated states have as important a role to play as the densely populated states in creating a new and improved national settlement pattern.

Figure 8 shows the areas in the United States that experienced population losses of 10 percent or more during the past decade. It is almost the photographic negative of the map showing the areas of high population density (see Figure 5). Ideally, the densely populated states would cooperate with sparsely populated states to achieve an optimum pattern of business and population growth for the entire country.

At the level of federal government, the interests of the Department of Housing and Urban Development stem from their involvement in new community development. The Postal

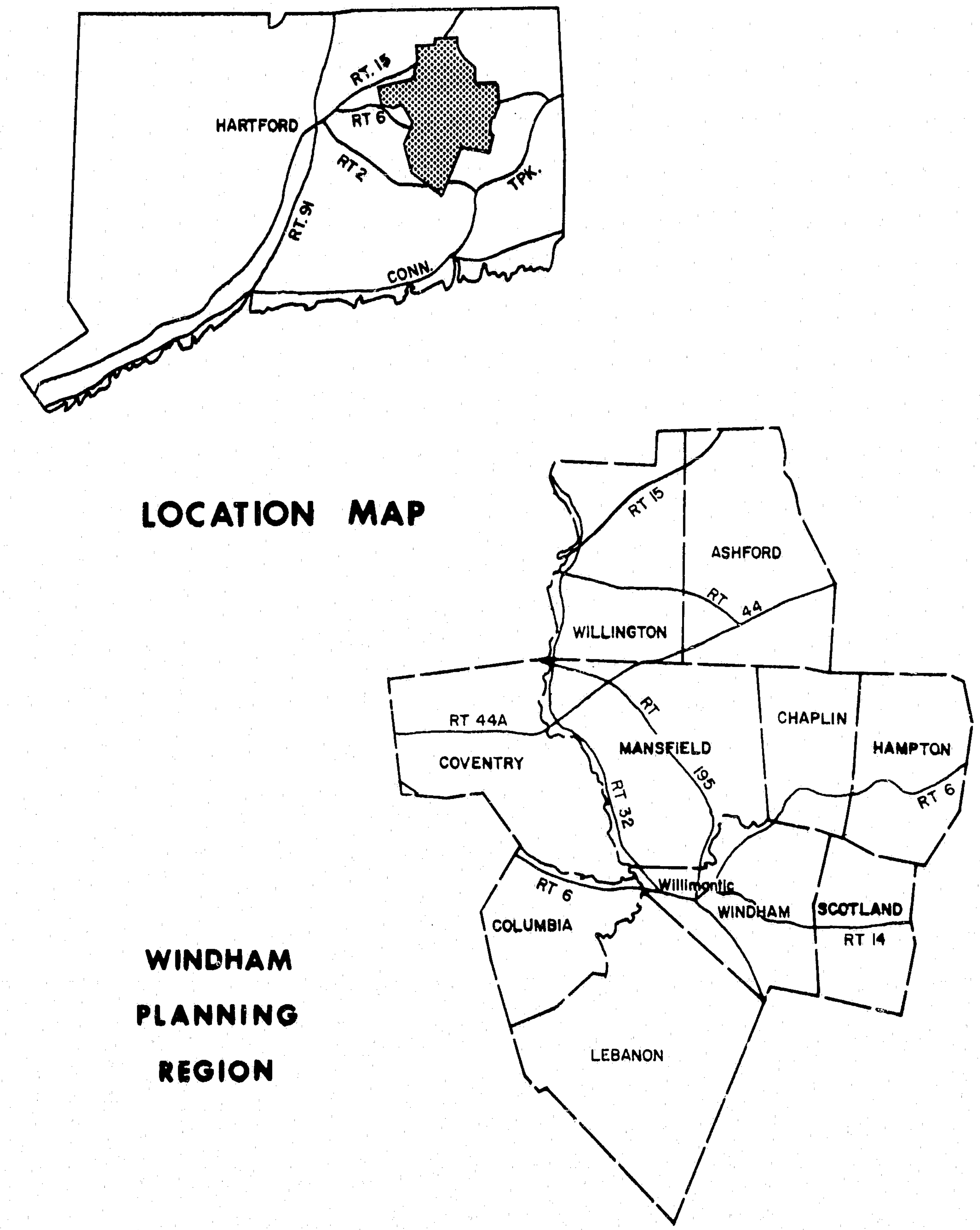


Figure 7

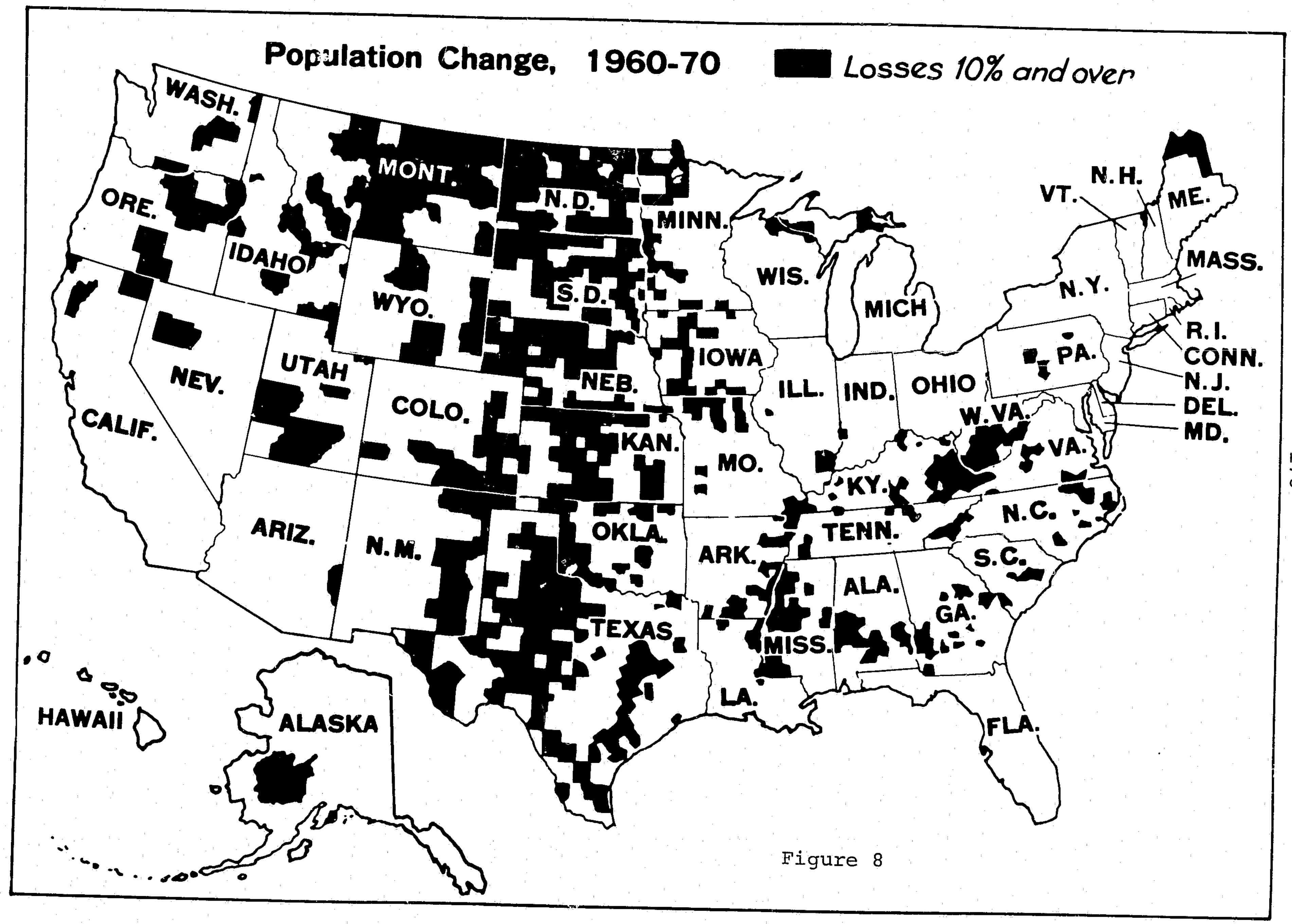

Population Change, 1960-70
Losses 10% and over
WASH.
ORE.
CALIF.
IDAHO
NEV.
MONT.
WYO.
UTAH
ARIZ.
COLO.
N.M.
N.D.
S.D.
NEB.
KAN.
OKLA.
TEXAS
MINN.
IOWA
MO.
ARK.
LA.
WIS.
ILL.
MICH
IND.
OHIO
KY.
TENN.
MISS.
ALA.
GA.
FLA.
S.C.
N.C.
VA.
W.VA.
PA.
N.Y.
VT.
N.H.
ME.
MASS.
R.I.
CONN.
N.J.
DEL.
MD.
HAWAII
ALASKA

Figure 8

Service is interested in improving present services and providing new services to communities. Some of the Service's research activity, possibly in experimental electronic mail systems, could be coordinated with the Joint Committee's efforts. The Department of Health, Education and Welfare has expressed interest in the telemedicine and satellite campus concepts.

The possibility would exist for the participants to share the funding and the use of Connecticut's broadband facility and thus prevent unnecessary duplication of expenditures, facilities and experiments. Through these and other shared activities, the Joint Committee will study a variety of state and federal problems relating to the issues outlined here, and will disseminate its findings nationally.

The Joint Committee is aware that this plan which envisions a redistribution of population, entails profound social, political and cultural implications. Some of these implications are relatively foreseeable and, indeed, the Cities of the Future concept is a response to the critical nature of current urban living conditions and an effort to achieve practicable alternatives. Nevertheless, it is desirable that the immediate goals of the plan and the means used to attain these, are carefully examined and criticized. It is also desirable that other approaches be considered.

The exploratory program is a first step, designed to ascertain the extent to which broadband communications could effect the overall development of communities in rural areas. If successful, then the program should be expanded to incorporate political and social scientists, psychologists, anthropologists, and others who could help assess the long range implications of this plan.

Regional Development

The following four sections indicate the purpose and scope, approach, schedule, and costs of the exploratory program proposed by the Joint Committee on the Cities of the Future and to be carried out in association with the appropriate Connecticut authorities.

Purpose and Scope

The program proposed by the Joint Committee encompasses

many disciplines, including:

- Communications Engineering - The design, installation and operation of the broadband communications systems.

- Business Operations - The analysis of the internal and external transactions and communications of a business and the means to handle these over broadband communications facilities between remote points.

- Health and Medicine - Exploration of ways in which existing medical resources can be best utilized through application of communications technology to provide diagnosis and patient care to people in the dispersed communities.*

- Economics - Analysis of the costs for various communications services and the extent to which business and industry can economically justify their use in the new living pattern.

- Education - Exploration of the satellite campus concept.

- Government - Exploration of ways in which state government can decentralize its operations away from the already crowded capital areas and, at the same time, bring its operations into closer proximity to the people.

- Arts, Culture and Entertainment - Development of new methods to make outstanding entertainment available on a regular basis to communities in rural areas; e.g., the transmission to local theaters especially equipped with high resolution large screen color television, of live performances of operas, Broadway plays, concerts, lectures, etc.

The Joint Committee proposes an exploratory program in Connecticut which involves four major complementary aspects that would proceed concurrently. They are:

1) Study with business, industry and government

*"...the number of physicians is growing at a faster rate than the population. The basic problem is maldistribution. There are too few doctors in the ghettos, in Rural America..." Elliot Richardson, Secretary of Health, Education and Welfare (N.Y. Times 4/2/71)

operations the specific nature of office procedures and communications which result in memos, letters, presentations, etc. and determine how these could be transposed onto broadband and other telecommunications media, and how as a result of this, business or government could effectively move components of their operations into rural communities.

2a) Explore with a number of towns within a region how to establish development standards and limits which would insure a growth pattern conducive to the highest quality of life.

2b) Coordinate the above efforts with relevant State agencies to assure that the development program is in the best overall interests of Connecticut. In turn, determine the need for the necessary supporting resources; i.e., utilities, surface and air transportation facilities, etc. based on given growth goals.

3) Experiment over broadband and other communication links with a variety of terminal equipment which would provide the services necessary for the companies and the government, as well as for all phases of life in the developing community.

4) Create an intergovernmental body of Federal and State officials which would cooperate with the Joint Committee and be responsible for initiating a coordinated, national effort based on the experiences gained by this project.

To carry out the exploratory program, the Joint Committee would work closely with several businesses and government agencies (state and federal), the University of Connecticut and a Regional Planning Agency.

The four aspects of the proposed program are described in detail below.

Business, Industry, and Government Aspect

A first undertaking of the Joint Committee would be to study the procedures and communications of business and government operations which are contemplating moves or new operations in distant rural locations.

This is the groundwork for later broadband communications

experiments. While allowing for the peculiarities of each organization, the basic study would indicate:

- the volume, nature, and destination (origin) of outgoing (incoming) telephone calls, memoranda, lectures, programs, conference materials, etc.
- the average length and duration of the above where appropriate.
- the costs that can be associated with the above items, i.e., for material, for secretarial time, and for business lost as a function of time-consuming procedures and mail delivery.
- the frequency, distance, and purpose of short distance (office to office business), and long distance travel. A cost figure will be derived where possible.
- the average daily, monthly, and yearly figures for the above.
- the extent to which the use of communications media would be an alternative to travel, and the effect of this on travel patterns, e.g., business trips, mass commuting, recreational travel, etc.
- The priorities for reception and transmittal of the various types of transactions; e.g., to ascertain store-and-forward and real-time requirements for future electronic media.

Although the study emphasizes the internal operations of the organization, the possibility exists to collect data on communications between the organization and its trade group and clientele.

The realities of business and government planning require that the Joint Committee allow for contingencies. For instance, in recent conversations, an insurance company offered to provide data from its own communications study, but was not planning to move any of its operations.

Another company is moving an operation to an adjacent state and is considering a two-way television conferencing link. The Joint Committee would like to ascertain the effect of the link on the company's operating patterns.

Ultimately the objective is to encourage a business or government office to move a component of significant size into a rural community and to help forecast and design the necessary communications systems. The Joint Committee would urge that the business submit its plans to the recipient town so that the necessary public works, housing and job training programs are initiated for the mutual benefit of both parties.

An important partner in this aspect of the study would be the Connecticut Development Commission which supervises the State's economic development and aids business in locating new operations.

The Regional Aspect

1) Regional Planning

As indicated earlier, communications technology is a necessary but insufficient ingredient for rural community development. It could be a major factor affecting a region's economic growth and ability to meet high educational, health care, cultural and entertainment standards, but may have little to do with other planning considerations such as utilities, the labor market, housing, tax structure, zoning, land availability, etc., which also must be provided. Therefore, the Joint Committee would work closely with the Connecticut Regional Planning Agency and its associated townships to design communications systems which would help the region achieve the optimum configuration of economic, educational and cultural development consistent with local aspirations. While the Joint Committee would be responsible for work with a high communications content, the planning agency would take steps to provide for all the other factors necessary for a healthful environment.

The regional planning agency, along with other appropriate groups within the region's townships, should undertake to assess the area's present physical, economic and social trends and characteristics and to set goals for the region's future. An important part of this task would be to determine the best sites within the region for various types of business, education, and government operations. This work would help insure the region's optimum development and indicate, among other things, the types and sizes of business, government and other operations which should be encouraged to locate within the region and whose communications the Joint Committee ought first to study.

It is contemplated that in a follow-on project to the exploratory program the Joint Committee and the Regional Planning Agency would jointly plan the communications networks that would make available to the community a full range of services, including some of those that the NAE's Panel on Urban Communications suggests be evaluated in existing large cities, e.g., systems to improve municipal management, the delivery of medical and educational services, etc.

One prospective partner for the Joint Committee is the Windham Regional Planning Agency. Windham County is a ten town area about 25 miles east of Hartford (Figure 7). Covering 326 square miles, the region's land is 82% undeveloped and only 5% classified as urban. The economy is based largely on the educational institutions, limited manufacturing, and homes of commuting workers.

Within the Windham region the town and surroundings of Willimantic have been considered to be most suitable for economic development. The presence in Willimantic of a college, a medical institution and several important businesses, including large branch offices of the Southern New England Telephone Company and Connecticut Light and Power Company, makes this area an excellent site for the Joint Committee's major broadband communications experiments.

A two-way microwave link already exists between Willimantic and Hartford and the Joint Committee would have limited access to this facility. Based on an initial series of experiments, the Joint Committee, in conjunction with the Regional Planning Agency and participating business, educational and medical institutions, may initiate licensing proceedings to acquire a permanent broadband link and terminal facilities. Such a system may be shared among a number of users to take full advantage of the available bandwidth at all times.

2) The University

The Joint Committee considers that a large and capable academic center such as the University of Connecticut, whose main campus is in the Windham region, could be the focus and catalyst for a rural development program. In January of 1971 the President of the University of Connecticut pledged the full support of the University for the exploratory program.

An important activity would be an investigation with the

University of the satellite campus concept whereby adults and college students in rural communities could study with a faculty at a local campus and be closely tied to a large university complex through interactive broadband communications media. The best ways to use communications technologies to supplement the offerings of a small faculty in a rural community would be studied. The abilities of the local faculty, enhanced by programming for the broadband communications network, should match the educational needs of the community. Issues pertaining to this problem are:

a) The location and population of the satellite campus town and of neighboring communities which it would serve.

b) The anticipated demand in the town and surrounding communities for various types of instruction at varying levels.

c) The nature of the area's existing educational resources; i.e., libraries, buildings, qualified personnel.

d) The distance of the town from the main university and other resources, such as a large city.

e) The expenditures by the main university to house and educate students coming from the satellite area.

f) The exact nature of the communications facilities necessary to support the local faculty.

g) The cost of supporting a satellite campus and the communications systems.

h) The number of students and adults attending the satellite campus who would not attend the large university.

i) The tangible and intangible contributions that a student community makes to town life.

Experimental Broadband Equipment and Systems Aspect

A series of experiments would be carried out to investigate and demonstrate the services that could be provided over a broadband communications system. For these experiments, the following transmission and terminal facilities would need

to be made available (perhaps on a temporary basis).

1) Transmission Equipment

Broadband transmission facilities would be needed which permit simultaneous two-way transmission between terminal points at video bandwidths (i.e., 5 MHz each way). A microwave link satisfying the conditions is available to the Joint Committee along routes of interest for limited periods of time and occasional use.

At a later date continual usage of a two-way broadband transmission link may be desirable; if so, an FCC license would have to be obtained, a tariff agreed upon, and additional equipment installed. Twelve to eighteen months are typically required for this process, of which 6-8 months are necessary for FCC licensing application and processing. Tariffs, all inclusive, generally run (depending on the classification of the license) from $2-5 thousand per month for the distances contemplated; i.e., 20-50 miles.

2) Terminal and Studio Equipment

Terminal devices would be set up at first in space provided by the Southern New England Telephone Company, whose transmission facilities may be used.

At each end of the link these devices would be arranged in a studio and would include high speed facsimile, high speed data sets, and provision for two-way television and audio conferencing.

Conference Television

Television screens and remotely controlled television cameras would be positioned in each studio so that optional arrangements for conferences between groups in widely separated locations could be studied. Transmission between two groups of conferees would be by two-way television and sound. A highly flexible two-way television conferencing system, which has been assembled and put at the disposal of the NAE-CRC Joint Committee, is presently being tested and could be installed temporarily in Willimantic and Hartford for demonstration purposes. A number of experiments would be carried out to determine the best type of conference for this medium; i.e., category of participant, format, number of people, structure of agenda, etc. This method would be compared to the alternatives of travel, telephone conference calls, etc.

Rapid Facsimile

a) Hard copy output

High speed facsimile (1-10 seconds per page) in which business and government is greatly interested requires broadband communication channels. It transmits electronically and prints an exact reproduction of the original document (letter, invoice, bulletin, etc.) at a remote location.

High speed facsimile equipment could be borrowed or leased for demonstration and use in the experimental communications link.

Businesses have indicated that their operations could be significantly improved by new or better modes of mail delivery. The Joint Committee would want to coordinate experiments with the Postal Service which has prime responsibility in this area.

b) Temporary image

Through storage and playback on a television type screen printouts can be made, if desired, on paper or microfilm. This form of facsimile may be used in many instances.

Electronic Data Transmission

Modern corporate and government operations increasingly require interchange of computer data between offices or sites. By testing various data input-output devices, the Joint Committee would ascertain the advantages of broadband transmission and the relationship of such data transmission to facsimile and conference television.

Of course, the maximum potential of existing and pending communications systems of all types would be considered, i.e., a telephone conference enhanced by directional sound sources.

Using these facilities, investigations would be carried out to accomplish the following:

- to learn how business interactions could be successfully handled by various types of telecommunications, if segments of a business were to move apart over significant distances.

- to discover ways in which state government could separate its operations and extend its presence over large parts of a state through the use of communications technology.

- to test the practicality and to identify the problems and the potential of the satellite campus concept. The NAE Committee's Subpanel on Education has recommended the development of course materials for computer-assisted instruction and a study of the role in education of cable television networks with narrow band response channels. The result of these projects should affect the design of communications systems for the satellite campus.

- to explore how existing medical resources could be best utilized through application of communications technology to bring care to people in remote areas. This might mean facilities which allow physicians in large hospitals to advise and educate paramedical personnel in small communities. Such tests and operations are underway in parts of the country and have been also recommended by the NAE subpanel on Health.

The experiments would have to be carefully designed to yield the maximum amount of data and to involve urban leaders, civic officials, university personnel, and others.

The Intergovernmental Aspect

The exploratory program in Connecticut should become a model that could catalyze similar or complementary efforts throughout the nation. To take advantage of this, an intergovernmental aspect of the exploratory program is proposed whereby representatives of federal government agencies and other states would become associated with the Joint Committee.

The three major tasks of this group would be to,

1) advise the Joint Committee on how the Connecticut program could be modeled to be most responsive to the needs and problems of the participating

states and federal agencies

2) apply the Connecticut model to these needs

3) initiate programs related to the Cities of the Future study in other areas of the country.

Fulfilling the third task would be primarily the responsibility of the state representatives. To begin, each would organize a task force within his state to collect the data necessary on which to plan for the most beneficial growth and settlement patterns for the state and to determine the role of communications technology in achieving these goals. A sampling of pertinent questions based on the Joint Committee's experience in developing the Connecticut program will be found on pages 192-3.

It is estimated that it would require 6 months for a state representative to organize the appropriate task force and to do the initial research. At the end of this period it is anticipated that a number of issues would emerge that either could be investigated within the context of the Connecticut program or would require the development of experimental programs in other areas of the United States. In designing these programs it would be desirable for the states to combine their resources and to coordinate their efforts. The possibility would exist for both the participating states and federal government agencies to share in the use and the funding of the experimental broadband facility in Connecticut, thus avoiding unnecessary duplication of expenditures, facilities and experiments.

Through the auspices of the National Governors' Council on Science and Technology, a number of governors' science advisors have become interested in joining the Joint Committee. An association with the Governors' Council to administer the intergovernmental program is contemplated. The governors of interested states could designate one representative who would attend approximately four meetings annually and would be responsible for initiating and directing the research program in his state.

In the Joint Committee's year-end report, the states would specify their plans and proposed projects for applying communications technology to achieve desirable growth and settlement patterns.

Because it is often difficult for states to finance the interstate travel of their officials, the Joint Committee

proposes that funds be made available for those representatives who would agree to undertake the advisory and research efforts outlined above.

Of course, provisions would be made to keep the officials of other states, who are interested in monitoring the exploratory program, informed of the Joint Committee's progress.

Approach

The proposed exploratory program can be carried out under the auspices of the National Academy of Engineering in cooperation with the Connecticut Research Commission or other appropriate Connecticut organization. The Joint Committee should be supported by a staff consisting of 3 to 5 people.

The focus of the Joint Committee's work would be flexible and broad enough to accommodate a number of contingencies. For instance, information, personnel and facilities may be available to pursue the health care aspect of the program during one period and the business communications aspect during another period.

Several state and federal organizations would be associated with the Joint Committee to carry out cooperative investigations. As these shared activities proceed, a cyclic alternation of research, experimental implementation, and further research would develop.

The Joint Committee recognizes the importance of the university as a catalyst and resource and has established a close liaison with the University of Connecticut. A number of joint activities are contemplated to involve faculty and students in aspects of the project.

A specific regional planning agency in Connecticut responsible for the target rural area would be closely associated with the Joint Committee. Of paramount importance is the expression of local aspirations and needs in the standards set for town development. The task to encourage business and government to move into rural areas would require coordination among the Joint Committee, the business or government agency contemplating a move, and the recipient town.

Joint Committee meetings should be held on a monthly basis and reports written at four month intervals

summarizing the work. At the end of the contract period for the exploratory program, the Joint Committee would submit a report stating its conclusions and recommendations and proposing the nature of future work. This report would be disseminated to key personnel in federal, state and local governments and to all Joint Committee participants and associates.

Schedule

The exploratory program proposed is a one-year project. The sequence and schedule of tasks would be as follows:

Yearly Quarters	1	2	3	4
Tasks	Establish working relationships with prospective participants* Analyses of communications and operating procedures data Set up temporary communications systems for experiment and demonstration	First experiments and demonstrations Review of findings Prepare half year report	Submit half year report Prepare second series of tests	Conduct second series of tests Review findings Begin planning for more permanent systems if this is indicated Prepare and submit year end report

Cooperation with participating region, university and state and federal agencies

Staff
Personnel
Required . . 3 to 5 persons . . . .

*The University of Connecticut, a regional planning agency, business and/or government operation, medical institution, other states, etc.

Cost

The Joint Committee estimates that the cost of the exploratory program proposed here will be on the order of $350 thousand.

Rental or lease of broadband communications lines and terminal equipment	$100,000
Salaries and overhead for 3 to 5 staff . .	$200 to 280,000
Travel expenses for 6 state representatives	5,000
TOTAL	$305,000 to $385,000

Questions Pertinent to Developing Other State Programs Based on the Connecticut Model

1) What is the existing pattern of population distribution?

2) What are the economic trends within the states?

3) On what factors has business and industry based its selection of locations (past and present)?

4) How can communications technology applied to business, government, health care and education improve these activities?

5) What types of broadband and other communications services will be needed to enable business and government to function effectively in rural communities?

6) What would be the cost of such facilities and what is the cost-effectiveness of the total service?

7) What costs should be borne by business and what subsidies, if any, are necessary and from what sources?

8) What major criteria affect a community's well-being and what are the forces that influence its growth?

9) What should be the method of community selection and the role of the availability of natural resources?

10) What is the existing and proposed network of road, railroad, and air transportation and what modifications might help stimulate the desired settlement pattern?

11) Which communities and areas in the state should be stimulated to grow?

12) What are the favorable and unfavorable impacts of these plans on the ecology of the community?

13) Are existing or planned highways feasible channels for underground broadband cable links?

14) What should the pattern and planning of decentralization be, and how can the new rural pattern help complement the urban pattern?

15) What local, state and federal planning agencies should be created, if any, to give the proposed plan the opportunity to succeed nationwide?

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***

Subpanel on Cities of the Future: Peter C. Goldmark (chairman); Harold Belcher, John Clinton, Emerson Markham and John Mock (advisors); Philip Weinberg (consultant); Roman V. Mrozinski and Thomas G. Newman, Jr. (staff).

Connecticut Research Commission: Warren C. Stoker (chairman)*, Hugh Clark, Charles H. Coogan, Jr., Peter C. Goldmark*, Sherman Knapp, John Lee*, Thomas Malone, David Martin, Henry Marx, George Royer*, John Burlew and Harold Heintz.

*Members of Connecticut Research Commission's Committee on Communications Technology chaired by Peter C. Goldmark.

APPENDIX A

BROADBAND CABLE COMMUNICATIONS

I. Cable Television During the 1960's

Community antenna television began to undergo a major change in its operation early in the 1960's. Important characteristics of this change are outlined below:

1) Prior to 1960, the standard system was built for five or less channels. In the 60's, the standard system was usually built for twelve channels, but in some cases, 20-32 channel capability was provided.

2) The Multiple System Operator (MSO) became a major factor. This development resulted from the desire for a stronger financial base and more efficient management.

3) In many cases, signals were received by a system using microwave from as far as a thousand miles away. Hence, the term "community antenna" is being dropped from most of the descriptions of cable operation.

4) Local program origination began on a small scale. Most systems now have provisions for telecasting local events, time and weather, and selected entertainment.

5) The Federal Communications Commission began in 1965 to assume strong regulatory powers in the CATV industry.

6) By 1970, at least sixteen manufacturers were supplying electronic materials to the CATV industry. At the present time there are over 250 businesses furnishing equipment, cable, programming, marketing, and consulting to CATV systems.

7) In the late 60's, "two-way" service or communications on the cable television system became the subject of considerable speculation, and by 1970, a few such systems were designed and built on an experimental basis. In actual fact, several hundred systems had limited two-way communications along portions of the trunk cable to provide for origination of programs in localities remote from the main distributing points. Only recently has the possibility of two-way communications between the head end and the subscriber been considered.

8) Potential non-entertainment applications of cable

television systems have begun to emerge. The possibility of the "wired city" and two-way cable communications is being discussed and planned. The technology is available; still in question are consumer demand and economic justification.

9) Cable television is now an established business. There are over 2,500 operating systems, with about 5,000,000 subscribers. Twice that number of homes have cable television available to them. Cumulative investment in system equipment and construction to date is in excess of $3/4 billion. Annual operating revenues are about $1/3 billion. At the present time, most customers connecting to the cable system do so for better reception and program variety. In almost every case, some form of off-the-air television is available before the cable system is built. In several cases, the CATV system duplicates the available television, but with better quality, a time and weather channel, and some local programming. Cable TV is no longer an exclusively small town phenomenon which provides television to those who would otherwise have none.

II. Present (CATV) and Future (BCN) System Characteristics

Most existing municipal CATV systems cannot obtain responses directly from subscribers or viewers. This subscriber-response or feedback feature could provide a significant opportunity for useful services to the community. Pilot projects involving such limited subscriber response are recommended in the body of this report.

The change of existing one-way CATV systems to feedback operation will occur, just as the growth of CATV is taking place, without further special encouragement. However, to illuminate the full benefits of a Broadband Communication Network (BCN) to urban areas, as it might develop from the present CATV systems, this appendix reviews the general characteristics of existing CATV systems. It suggests the modifications to these systems to provide the services of a Broadband Communications Network, and finally, suggests ways in which pilot projects involving limited two-way communications can be tried in urban areas where only one-way cable service is presently provided.

A. Present CATV Systems

CATV systems have resulted from the desire of rural area residents to view urban TV programs. The TV signal strengths in these rural areas are too weak to be picked

up by conventional household TV antennas; thus entrepreneurs, sensing a market, set up master community antennas equipped with low noise pre-amplifiers and then distributed the signal via coaxial cable to all who would pay for the resultant clear picture.

1) Head End

The antenna complex usually includes frequency converters that change the viewing channels to unused TV channel numbers to avoid interference from direct "off-air" transmissions, as well as to take advantage of the lower frequencies where coaxial transmission losses are less (e.g., UHF channels are always converted to VHF channels). Signals are also separated into their video and audio portions, precisely leveled, and recombined. This leveling allows adjacent channels on TV sets to be used, thus doubling the number of usable channels in any given area. This originating point consisting of antennas, pre-amplifiers, converters, and signal levelers is called the "head-end" of the CATV system.

2) Signal Distribution System

The signal distribution system from the "head-end" to an individual subscriber's home is very analagous to the above-ground configuration of a tree with its main trunk, branches, and finally the leaves (homes). This tree type of distribution provides a simulated broadcast mode of operation and allows no individual routing of signals to individual subscribers.

As the signal must travel from the program origination point and be continually divided throughout the coaxial distribution system, amplifiers are provided at discrete points. These amplifiers maintain a relatively constant signal strength throughout the system, but each amplifier also degrades slightly the signal quality. This latter phenomenon limits the total length of the overall distribution system to 15-20 miles. The total system length is dictated by the total number of channels and the intermodulation characteristics of the amplifiers.

Selectivity of distribution is provided manually by connecting an individual home, a block of homes, or an entire neighborhood. Communication from the home to the head-end or program origination point is available only in a few of the existing cable distribution systems on an experimental basis.

3) Terminal Equipment

At the present time the home terminal equipment is the conventional TV set since the original signal structure is unmodified by the distribution network.

4) Overview

Within the decade of the sixties, significant CATV penetration took place in major urban areas. The inherent potential of CATV systems comes from the very nature of the coaxial cable and its built-in economic incentive to spread throughout the community as the third wired system, after the electric power cables and telephone lines. The coaxial cable has a large broadband capacity that greatly exceeds any previous wire distribution system of the city. Present hardware is able to simultaneously carry frequencies up to approximately 300,000,000 cycles per second (300 MHz). The present telephone network, consisting of a randomly selected twisted pair, can handle only up to 3,500 cycles per second (5KHz) of communications. With higher grade preselected and dedicated lines, and with line equalizers and other sophisticated techniques, this can be extended to the 1.0 to 1.5 MHz range.

A further idea of the increased capacity of cable systems may be gleaned from the present FCC frequency assignments in this 0 to 300 MHz band for over-the-air or radiated signal transmissions, namely

0 - 54 MHz	Fixed and mobile transmitters
54 - 88 MHz	TV channels 2 - 6
88 - 108 MHz	FM radio
108 - 174 MHz	Aeronautical radio navigation, air, land and maritime mobile
174 - 216 MHz	TV channels 7 - 13
216 - 300 MHz	Fixed and mobile radiolocation

From this comparison it is easy to see that the coaxial cable can do more than just simulate the broadcasting of 12 TV channels. The limiting factor on the total number of channels is not the coaxial cable, but the hardware of amplifiers, couplers and dividers used to support the coaxial distribution system. Twenty or more channels, each 6 MHz wide,

are available for use in the near term.

It is with this added channel capacity that urban improvements can be realized. Urban franchisers can realize this potential by reserving a specific number of channels for public and municipal use. Finally, the FCC has required that CATV operators with more than 3,500 subscribers provide locally originated programming by April 1, 1971 (a requirement which is being challenged in the courts). Approximately 420 system operators throughout the country are affected by this FCC ruling. It is universally accepted that the prospect for innovative local programming by citizen groups, municipal governments and operators is very promising.

B. Broadband Communications Network (BCN)

Some modifications to most existing city CATV systems will be required before they can approach their potential as Broadband Communications Networks (BCN's). This does not mean that these modifications are required before any innovative services can be introduced. On the contrary, the present simulated broadcast mode of operation can provide quality public service programs such as Sesame Street and the Forsyte Saga. However, to obtain the full potential of the various new services, particularly those which involve citizen response, modifications will be required for the head-end, distribution system and the home terminal. Significant civic improvement can be expected from the citizen response feature.

Two basic changes will need to be made within the cable distribution system to obtain citizen responses. First, the hardware in the coaxial cable distribution system needs to be modified to allow two-way operation. That is, signals should be allowed to flow from the subscriber's home terminal back to the head-end. Second, the distribution system should be changed to allow computer-programmed signal distribution to individual subscribers, or at least to groups of subscribers. Wiring a second urban cable network may be justified for public service purposes, particularly when the same communications ducts can be used.

Although selective broadband communications from any network subscriber to any other subscriber is technically possible, it will be slow in coming becuase of its high cost. Further in-depth study is needed of the economics of such networks.

1) BCN Program Origination Facilities

Program origination would no longer be restricted to the head-end, since the two-way feature would allow the origination to occur at such diverse points as a library, medical records bureau, motor vehicle bureau, etc. and be transmitted back to the head-end for computer distribution anywhere in the network.

Using computer polling and addressing techniques, individuals or groups could receive special programs. For example, all the metropolitan area's doctors, educators, AB negative blood types, or municipal employees could be designated to receive information of sole interest to them.

a) Polled Digital Subscriber Response System

The principal use of a limited two-way service is likely to be to transmit very simple messages from many subscribers to the main studio in a short time. An example is an audience participation show in which each viewer is asked to indicate his preference among four alternatives by punching button 1, 2, 3, or 4 on his home terminal response pad. In an educational setting a student might be asked to participate in a class by indicating his choice among a similar number of alternatives. The computer at the studio would compile a histogram showing the number of responses to each alternative, thereby providing feedback to the teacher to go ahead, or possibly to review the material, if the audience has failed to comprehend it.

Several levels of flexibility and terminal complexity are possible here, with more flexibility and terminal complexity naturally being associated with higher cost. In any subscriber response system the basic system design is similar to that of a polled-teletype system, and in fact, one system alternative is exactly that, with each subscriber having the choice of one of, say, three terminal options, a four-button response pad, a twelve-button touchtone pad, or a standard teletype keyboard. The message typed out would be sorted locally, and naturally, the more storage provided, the higher the cost. The computer at the main studio would then send out a message to each terminal in turn, probably using the address of each terminal to let the terminal know it was ready to receive its message. If the terminal had a message, it would then transmit it, using the channel assigned to subscriber responses in the reverse direction, i.e., from subscriber to main studio. The computer at the main studio would store this message in its

memory for whatever use was next intended for it and the subscriber's local memory unit would be cleared to receive the next message from the subscriber.

In a possible design for such a system each subscriber might have up to 100 bits of local memory and be polled once every 10 seconds. If half of this 10-second period were used to send messages from subscribers, and if there were 50,000 subscribers, the system would require a data rate in the return direction of 100 times 50,000 or 5 million bits per 5 seconds which would require the use of about one TV channel, with the exact band width required depending on the method of modulation used. As the round trip signal propagation delay along the cable in CATV systems covering radii of 15-20 miles is comparable with the time period which each of 50,000 subscribers is allocated for response, further technical study is required to determine the optimum economic solutions to this constraint.

Possible solutions include limiting the geographical area covered by the system, dividing the 50,000 subscribers into discrete groupings of say 10,000 subscribers with each group handled independently, and increasing the sophistication of the subscriber terminal by adding delay to the closest in terminals.

This type of system allows only a very low data rate by teletype standards, 10 bits per second which is less than two characters per second versus 10 to 30 characters per second in a typical teletype system. It, however, is very powerful in terms of the number of subscribers polled. Note that a local telephone system could not possibly handle a load of this type in which 50,000 subscribers simultaneously call a single other subscriber.

If it were desired to offer higher data rate service in this type of system to some subscribers, two alternatives are available. In one, a special extended message format could be allowed for in the polled system design and, if only a relatively few subscribers had long messages in any one poll, the polling rate would not be slowed down very much. In the other alternative, special dedicated return channels could be offered, equivalent to telephone or teletype lines, so that a subscriber could be connected to the central computer through the cable system in essentially the same manner that a subscriber can now be connected to a remote computer through a telephone line.

For many instructional purposes, a polled system with

a data rate of 10 bits per second from subscriber to computer as suggested above would be entirely adequate. A higher data rate might be desirable from computer to subscriber, if individual messages were to be sent to each subscriber, as in a computer-assisted instruction system using teletype terminals. In this case 10 characters per second is about as low a speed as users are comfortable with. Slower speeds require too long a wait to receive typical messages from the computer.

In summary, the polled subscriber response system provides a basic tool for a wide variety of educational services, including both a restricted form of computer-assisted instruction and instructional TV with student participation via simple responses. In addition, it provides the basic mechanism that allows subscribers to call for other services as needed, such as the use of a private channel to a computer at the main studio, or access to a pay TV channel. It could also be designed to supply the subscriber-to-main studio channel at full teletype speed for a variety of interactive individual services such as interactive computer or interactive library services.

b) Audio Subscriber Response System

In many instructional situations it is important to provide for student participation via direct questions. The Stanford Instructional TV system is an example of this type of system. It is an over-the-air system in which audio response is allowed from each remote installation, so that any student can ask a question at any time. A cable TV system with a polled digital subscriber response system, would enable each student to ask for an audio channel by pushing the right buttons, and then for the teacher at the main studio to assign a channel to the student when it was appropriate to do so. If there were a very large group participating in a course given by TV, only a small fraction of the students would be able to ask questions because of the limited time, and the subscriber response system would provide a convenient mechanism for handling this time allocation problem. Only one audio channel at a time would be used for any one course, so the total number of audio channels required for this purpose would only be equal to the number of outgoing TV channels, and hence would not be a large requirement on the two-way system.

2) BCN Signal Distribution System

One possible distribution concept could consist of electronic neighborhoods, that is, miniature versions of

the larger or master distribution system repeated in each major neighborhood of the overall system. These neighborhood distribution systems could be semi-autonomous in their operation on one or more channels and could easily be electronically connected to adjacent neighborhood distribution systems. Further along, any neighborhood could originate programs in its own studio and make it available to other neighborhoods on a common channel.

The makeup of these neighborhood groupings is extremely important. Study is needed to determine the criteria for their content including such factors as total population, racial and economic mix, citizen desires, natural geographical limits and network hardware restraints. Although some national guidelines are probably desirable, the neighborhood theme needs stressing and local autonomy should be encouraged.

3) BCN Terminal Equipment

The home terminal should allow the origination of signals by the individual subscriber; at a minimum, the subscriber should be able to indicate a multiple choice preference, or a combination of multiple choices. Basically, this is simply a field of yes/no type responses. As an extension of this, the subscriber should be able to enter typed messages that are digitized by his terminal and sent in burst fashion over the line. Similarly the home reception of data using a high-speed printer or electric typewriter is presently feasible. Facsimile signatures will soon be available.

Obviously the subscriber should be able to receive other than TV screen images. His total home terminal might include some combination of a TV set, with or without single frame (alpha-numeric or video) hold and refresh, a high-speed printer and/or computer-driven electric teletype or electric typewriter, a telephone, video tape recorder or cassette, and a facsimile receiver. Innovative combinations of these home terminal devices coupled with appropriate headend equipment (e.g., a computer) will provide a spectrum of user services limited by the system designer's imagination and the cost of providing these services.

To receive this relatively private type of message requires the home terminal to have a specific address which the head end computer-transmitter inserts into the transmission. Such prototype devices are already operating in

several laboratories.

4) BCN Pilot Projects

Pilot projects involving cable TV systems will be constrained by the hardware and distribution systems presently in existence. However, it should be obvious that CATV pilot projects that require the simulated broadcast feature of the distribution networks can be tried immediately and directly on any of the many existing CATV systems. Thus experiments requiring the wide bandwidths for the information transfer, and taking advantage of the heavy consumer investment in TV sets are immediately implementable in existing CATV systems.

Examples of remote programming would be pickups of real-time events by mobile cameras, or projects where the resources of the programmer could not be easily duplicated at the head-end studios, such as university laboratory experiments. Video links from remote sources to over-the-air TV programming studios are commonplace.

Pilot projects designed to exploit the vast advantages of subscriber feedback, or BCN, will find relatively few systems with which to experiment. To provide a wider field of possible implementation, it would be worthwhile to consider simulated modes of operation where all the technical characteristics were equivalent to a basic BCN system of operation and where the subscriber interaction could be evaluated under controlled conditions.

One of a family of possible simulated modes of operation would be the creation of special subscriber centers. These centers (located, for example, at day care facilities, prisons, and hospitals) would provide a significant portion of the "outside" video world directly to these individuals, while at the same time providing an ideal situation for controlled experimentation.

These subscriber simulation centers could be hardwired back to the head-end via dedicated telephone lines; telephone lines would be acceptable for the return signals since the data rate of switch closure type responses is relatively small.

5) BCN Emergency Interrupt

The basic feature of access to all program origination points by the head-end of CATV networks allows

for easy implementation of an all channel emergency interrupt feature. The emergency interrupt could be implemented by the responsible local official to warn citizens of emergencies; such as forest fires, heavy snow conditions, floods, tornadoes, and national emergencies. The municipal government in cooperation with the CATV owner would establish procedures for its use.

III. Video Cassettes and Municipal Information Systems

This section explores one possible use of video cassettes in an Intracity Broadband Communication Network. Although primarily directed at a municipal information application, the concept is equally applicable to such services as training (police, fire, GS grade advancement, etc.), reference material for municipal employees, law enforcement data transfer (mug shots, fingerprints, photographic evidence, etc.) and other applications.

It is not hard for any urban dweller to visualize the daily citizen queues in front of the myriad of different city departments. Each department could easily make up a list of inquiries that would represent many of the citizen's areas of interest. Indeed, to satisfy these repetitive inquiries, each department has handout brochures describing the services, reporting requirements and schedules. The amount of vehicle traffic generated daily by these citizen inquiries may be considerable.

Combining the technology offered by video cassette recording and the neighborhood channel concept of Broadband Communications Network (BCN) provides an exciting opportunity for municipal governments. Video cassettes that describe these city services, answer high volume questions and give related information can be reproduced and stored. A subscriber could request a field of specific information from any of the different city departments. This request would be transmitted to his neighborhood municipal information center for automatic processing. If the channel were open and the cassette available, it would be played back via subscriber-addressing technique to the requester's home terminal for storage and later viewing and, in parallel, on to the subscriber's TV screen. Thus, if the information was not fully understood the first time, the subscriber could replay the cassette at his option without re-addressing the neighborhood municipal information center.

Repeating the cassettes in each of the neighborhood

municipal centers would improve its immediate availability. It would also improve the efficiency of the assigned BCN municipal channel for the entire network. To provide non-realtime responses where the demand was too great even for the neighborhood municipal channel, 24-hour response service could be provided, since many of the requests would, of course, not require immediate response. In these cases, the BCN network would transmit the video data during off hours (e.g., early morning hours) when the channel could be expected to be relatively free. The information would then be stored in the home terminal for viewing at the subscriber's leisure.

Study is needed of the techniques for making adequate use of cassette technology. The technological feasibility of the concept is generally accepted, but the municipal implementation schemes are presently vague. The study would be designed to determine all aspects of the feasibility of this concept, while at the same time, if proven feasible, provide the city government with another alternative as to what it might do with its reserved municipal channels.

* * *

APPENDIX B

MOBILE RADIO TECHNICAL CONSIDERATIONS

Aside from the improved reliability associated with the use of transistors, one major advantage derived from the use of solid state components in mobile radio application is the substantial reduction in standby current associated with the mobile installations. While at first most of the urban installations have been concentrated in the 150 MHz band region, within recent years, there has been a rapid and wholly successful increase in the use of the 450 MHz band for all of the categories of allocations. In the trade-offs between the propagation characteristics, noise level and design complexities, it would appear that the 150 MHz band and the 450 MHz band provide approximately equal service. In an effort to make more mobile capacity available the 900 MHz area is beginning to be developed.

When considering the design restraints concerned with the maximum utilization of spectrum space, it must be remembered that in the mobile band assignments, the width of the signal or voice transmission bandwidth is not the only consideration. The use of R.F. (radio frequency) selectivity to exclude adjacent channel interference is not possible economically without setting constraints.

The radio-equipped cars operate under widely varying conditions of electrical noise, shadowing, standing-wave signal variations, and interference from other systems. For this reason, it is common practice to employ 250 watt base stations while the power transmitter for the mobile transmitter units may be somewhere in the 20 to 50 watt range. The system assumes that the base station receiving location will be characterized by a uniformly low noise level. Because of the relative high power at the base stations, and the use of elevated antennas, it has been desirable in most cases to operate mobile and base station equipment on different frequencies. With this two-frequency approach, it is possible to duplicate assignments with comparatively short geographic separation without wiping out the adjacent system's mobile transmissions back to headquarters. Where only one frequency is used for both mobile and base station units, the adjacent high powered base stations can block out the talk back from the low powered mobile units.

Perhaps it should be pointed out that efficient channel loading may not always depend upon a superior signal-to-noise

ratio for protection against duplicate assignments on the same channels. Extraordinary efficiency in message handling under degraded signal conditions has been demonstrated by the taxi dispatch services where by the use of redundant voice transmission and by adhering to minimum message transmissions, the volume of successful traffic handled despite severe interference has been very high.

In the police systems, the voice dispatch approach for small departments has been adequate, but in the larger cities it has been necessary to install multiple-channel coordinated systems and to develop techniques for speeding up the processing and transmission of emergency messages. In several of the larger cities, work is going forward with the exploration of computer-aided dispatch systems and proposals are under consideration for the addition of vehicular location equipment which will enable a continuous watch to be made of the location of all vehicles operating in the system.

While there is no wide use of teleprinting in cars today, such printers are available and some police departments are considering the installation of test printer units in cars together with digital keyboards for print-out response.

Selective calling has been available for use in mobile systems for many years, but because of the expense and particularly because of the reduction in the speed for establishing contact, little use has been made of the system except for public telephone systems where its use has been universal. A technique known as continuous tone-coded squelch, on the other hand, which codes the response of all cars in a system to a single base station, has been widely used. This system permits a base station to open the squelches of all of the cars in its system, but all the squelches will remain closed when out-system base stations operating on the same frequency go on the air. This technique has been effective in reducing the annoyance caused by squelch openings and chatter generated by stations outside of the system.

Common carrier dial telephone systems are used in many places in the United States to provide telephone connection between the equipped mobile units and the wire telephone system. While the equipment has worked well, the limited number of channels available for the service frequently limited the number of calls which could be handled, and queueing resulted. The recent assignment of spectrum in

the 900 MHz region for common carrier telephone use should make it possible to develop an effective trunking system which will substantially increase the number of messages which can be handled. It is expected that 900 MHz will prove to be nearly as satisfactory as 450 MHz for urban communications and any important negative trade-offs can probably be balanced by the use of geographically spaced receiver installations. Additional spectrum has been assigned in the 900 MHz region for the other mobile services, and the greatest limiting factor for relief of the present conditions of spectrum crowding is the estimated time of 5 to 7 years to bring the 900 MHz equipment to a mature state of development.

One of the areas of very substantial increase in voice communications has been in the portable radio field. The introduction of solid state components has made possible the production of small reliable portable units with power outputs ranging all the way from a fraction of a watt up to 10 watts. Two-watt portable units are available for 450 MHz band and powers to 10 watts and more can be purchased for operation in the 150 MHz region. The lightweight, small size, the improved reliability and the rechargeable nickel-cadmium battery have all contributed to the evolution of a practical hand-carried unit for police, fire, and many industrial and working operations requiring coordination and control. Police use the portable unit for foot patrol work and they can also make use of portable units to communicate between an officer in a high-rise building and his patrol partner parked in a car at the base of the building. 150 MHz units usually perform very well for masonry structures, but the 2-watt 450-MHz portable transmitter and receiver performs exceptionally well for the more open steel frame structures. While the absorption of signals through masonry walls is less at 150 MHz, the transmission of 450-MHz signals through the glass and steel structures is superior due to the large effective apertures.

In summary, it may be stated that, while the performance considered in terms of the transmission and reception of the message under favorable conditions has not changed for mobile and portable equipment substantially over the years, there has been a radical and substantial change in the design and in the rise of sophisticated maturity of the equipment, with special reference to the generation and control of interference. Substantial improvement in the efficiency in the use of the spectrum has been achieved by continual equipment and systems design improvements.

In the future, the increased use of integrated and hybrid circuits will further reduce the size and cost of equipment, while increasing the reliability and the degrees of freedom available for unique design characteristics. For example, selective calling has been too costly and slow in the past, but it will be possible in the future to provide a selective coding system to handle more than a million calls on a single integrated circuit silicon chip. Further universal development could provide for countrywide monitoring and identification of every car in every city and on every highway. Active traffic control coding systems can also be included in all cars of the future if such an approach seems to be desirable. A rapid and continuing increase in the number of mobile portable voice radio communications units in use can be anticipated so long as channel space is available to prevent the degradation of service and the rise of undesirable noise levels. The present day mobile communications equipment represents sophisticated, mature design for the present state of the art, and a continuing evolution of advanced systems design may be anticipated as the channel space available is increased.

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APPENDIX C
CITIES' REACTIONS TO PROJECT RECOMMENDATIONS

The following is an analysis of city responses to a summary-questionnaire circulated through the cooperation of the National League of Cities, the International City Management Association, and directly by this Committee. The questionnaire summarized the pilot project concepts presented in Chapter III of this report and asked a series of questions concerning the potential usefulness of the projects to cities.* The questions used are shown on page 216.

An initial analysis of city responses to the projects offers some preliminary indicators as to where interest, *vis-a-vis* cities, lies in regard to these projects. An analysis of city comments, in addition to the simple tabulation of data, provides additional insights. First, let's take a look at the projects and compare them one with another. By analyzing the quantifiable responses to the city questionnaires, it is possible to develop some rough correlations of interest by cities in each of the projects.

Table 1 shows each project listed with high/low indicators given for each question asked of the cities. A check mark in the high column means that there is a positive correlation, while the low column indicates a low correlation. Therefore, an optimal situation for any project in terms of city attitudes would be check marks in the high columns for all factors except adverse social, political, and economic factors.

If the above standards are acceptable, an examination of Table 1 shows that five projects would evolve as highest-priority items in terms of positive city reactions. The five are:

1) Community Information Center

2) Automatic Location Identification

3) Air Pollution Monitoring Instrumentation

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*The projects listed for city reaction in Appendix C do not coincide exactly with those in Chapter III, as the city reactions were solicited while the projects were still being developed. These differences, however, do not invalidate the overview of trends in city reaction to the various concepts.

4) Technology Handbook for Urban Cable Planning and Franchising

5) Interactive Home Terminal

The main message being transmitted by the cities in selecting four of the above areas is simply, "We're involved in these program areas now. The job being done is not adequate. We need all the help we can get." For example, decentralization of city services is an urgent item in cities. The Community Information Center has a direct impact on this issue, which makes it one of interest. The Emergency Telephone Number (911) system is being used by some cities and carefully evaluated by many others. Automatic Location Identification (Item 2) impacts in this area. Items 3 and 4 are areas of high interest in just about every city over 25,000 in the U.S. today. Any assistance available will help cities to do a more effective job in the areas of air pollution monitoring and cable planning. The Interactive Home Terminal (Item 5) is a concept in which city officials see great potential, but probably are vague as to specific uses. It must be noted that of the five items of greatest interest, the cities picked four which have a direct impact on current day-to-day operations. Only the Interactive Home Terminal (Item 5) is somewhat futuristic. This ordering of priorities by the cities might be carefully noted by funding agencies. The cities want assistance in performing today's tasks more effectively. Only after such progress is made will most cities be ready to crawl out on the limb with more speculative programs.

Table 1 should also be analyzed in terms of a second grouping of priorities. Such a grouping shows the following areas:

1) Two-Way Educational Delivery System

2) Computer-Assisted Instruction

3) Transit Information System

4) Twenty-four Hour Television Surveillance of Streets

5) Personal Alarm System

It should be pointed out that Twenty-four Hour Television Surveillance of Streets (Item 4) in this second grouping could have major impact upon street crime in most municipalities. Table 1 shows a high positive correlation for most aspects of such a system until the political and social response is projected. Anticipation of a negative attitude by the populace

toward such surveillance causes this project to drop from Group One to Group Two. It is likely that a security system focused on public housing, and public institutions like schools and hospitals, would have ready citizen acceptance. However, the justification and use of any public or institutional security system requires adequate prior discussion with the affected public. The invasion of privacy and other social implications of these concepts must be explored in order to determine public acceptability.

Recommendations for Future Analysis

The above discussion is a brief summation of city attitudes which can be drawn from the city questionnaires. More information is needed prior to any decision-making regarding project and prototype development. For example, factors regarding cost must be considered. Measurable impact upon city services of each of the projects must be measured. Potential city purchasing power has to be considered, along with industry potential for large scale production at a reasonable price. These are a few of the detailed analyses which must be undertaken prior to the initiation of activity in developing, testing, and operating any of the identified projects.

TABLE 1

SUMMARY OF CITY RESPONSES TO QUESTIONNAIRE

Project Title	Existing Service More Effective		Meet Demand for New Service		Adverse Social, Econ. Factors		Reception by Residents		Test Site Interest	
	High	Low	High	Low	High	Low	High	Low	High	Low
Community Information Center	X		X			X	X		X	
Two-Way Educational Delivery System	X		X			X	X			X
Computer-Assisted Instruction	X		X			X		X	X	
Interactive Home Terminal	X		X			X	X		X	
Special Recommendations		X	X			X		X	X	
Telemedicine System Parametric Study	X		X			X		X		X
Nursing Home Medical Care Project		X		X		X	X			X
Air Pollution Monitoring Instrumentation	X		X		X		X		X	
Transit Information System	X		X			X	X			X

TABLE 1
(Continued)

Project Title	Existing Service More Effective		Meet Demand for New Service		Adverse Social, Econ. Factors		Reception by Residents		Test Site Interest	
	High	Low	High	Low	High	Low	High	Low	High	Low
Transportation Transfer Facility	X		X			X		X		X
Transportation-Communications Study	X		X			X		X		X
Twenty-Four Hour Television Surveillance of Streets	X		X		X		X			X
Personal Alarm System	X		X			X	X			X
Automatic Location Identification	X		X			X	X		X	
Municipal Command Center	X		X			X		X		X
Technology Handbook for Urban Cable Planning and Franchising	X		X			X	X		X	
Automatic Vehicle Monitoring (AVM)	X			X		X		X		X

Questions from City Reaction Questionnaire

1. Would this project enable a city to perform an existing service more effectively?

   Yes ____
   No ____

2. Would this project enable the city to meet a demand for a new service?

   Yes ____
   No ____

3. How do you think the service provided by this project would be received by the city's inhabitants whom it is meant to serve?

   Enthusiastically ____
   Moderate interest ____
   No interest ____
   Opposition ____

4. Can you foresee any adverse social, political, personnel, or economic factors to providing this service in your city? If yes, please describe briefly.

   Yes ____
   No ____

5. What degree of interest would your city have in serving as a test site for a federally-sponsored pilot project to demonstate this service?

   Very enthusiastic ____
   Quite interested ____
   Moderate interest ____
   No interest ____

Comments:

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GLOSSARY OF SELECTED TELECOMMUNICATIONS TERMS

Broadband Communications Network (BCN): A communications network with a capacity for the exchange of large quantities of information in both point-to-point and broadcast modes.

Broadcast Communications System: A system providing one-way information flow from a single location to many users, e.g., commercial television broadcasting or one-way cable television.

Cable Television (CATV): A communications system by which a subscriber receives signals via cable for display on a television set. Signals are usually provided by commercial and public broadcasters. The system consists of a head-end, a cable distribution system, and many television receivers.

Coaxial Cable: A cable that consists of a tube of electrically conducting material surrounding a central conductor held in place by insulators, having a high capacity for transmitting information (as many as 40 television signals simultaneously on one cable).

Frame Grabber: A local storage device which receives and stores a single frame of video information for display on a television set.

Head-End: The central distribution point for signals in a cable television system.

Interactive Terminal: A user terminal device which allows subscriber reception and initiation of signals. An example is a television receiver with a touchtone response pad.

Limited Two-Way Communications or Limited Subscriber Feedback: A feature in a cable television system that enables the subscriber to respond to incoming messages for such purposes as polling, merchandise ordering, question response, etc.

Local Memory or Local Storage: Electronics which allow the storage of a received signal for later playback.

Point-to-Point Communications System: A system providing information exchange between any two subscriber locations, e.g., the telephone systems.

Polling: A technique for gathering simple signals from cable television subscriber terminals by means of limited subscriber feedback communications channels, usually involving computer processing at the head-end.

Response Pad: A device, part of an interactive terminal, that enables the subscriber to initiate push-button-type information.

Wired City: An evolving concept of urban communications in which information transfer between fixed points is primarily by means of wire cable networks. Both point-to-point and broadcast-type communications services would be provided by integrated complementary networks.

Wire Pair Cable: Two wires, usually twisted together, and capable of transmitting relatively small amounts of information (up to about 10 KHz or about 25,000 bits of information per second).

END