TECHNOLOGY FOR THE CITIES—First Annual Report of the Public Technology / National Aeronautics and Space Administration Technology Application Program/1971

Acknowledgements

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Program officers Royal G. Bivins Jr. and James T. Richards Jr., and Jeffrey T. Hamilton, Director, of the Technology Utilization Office at NASA have provided valuable guidance to the program. The Technology Application Groups at Abt Associates, Inc. and George Washington University, under contracts to NASA, have generously provided technical support without which the present accomplishments would not have been possible. The technical design inputs from the NASA Field Centers at Manned Spacecraft Center, Marshall Space Flight Center, and Lewis Research Center and consultations from several other NASA centers are greatly appreciated.

The jurisdictions participating in the program have provided valuable staff time to identify and evaluate problems and respond to numerous inquiries. Particular thanks go to the *members of the project's* National Coordinating Committee and User Design Committees for their extensive participation, valuable advice, and enthusiastic support.

The Project Director at Public Technology is Warren D. Siemens. The constant support and advice from Porter W. Homer, President of Public Technology and from Senior Vice Presidents Picot B. Floyd, Ronald J. Philips, and J. Robert Havlick have been invaluable to all phases of the program. They have been particularly helpful in enlisting the participation of cities.

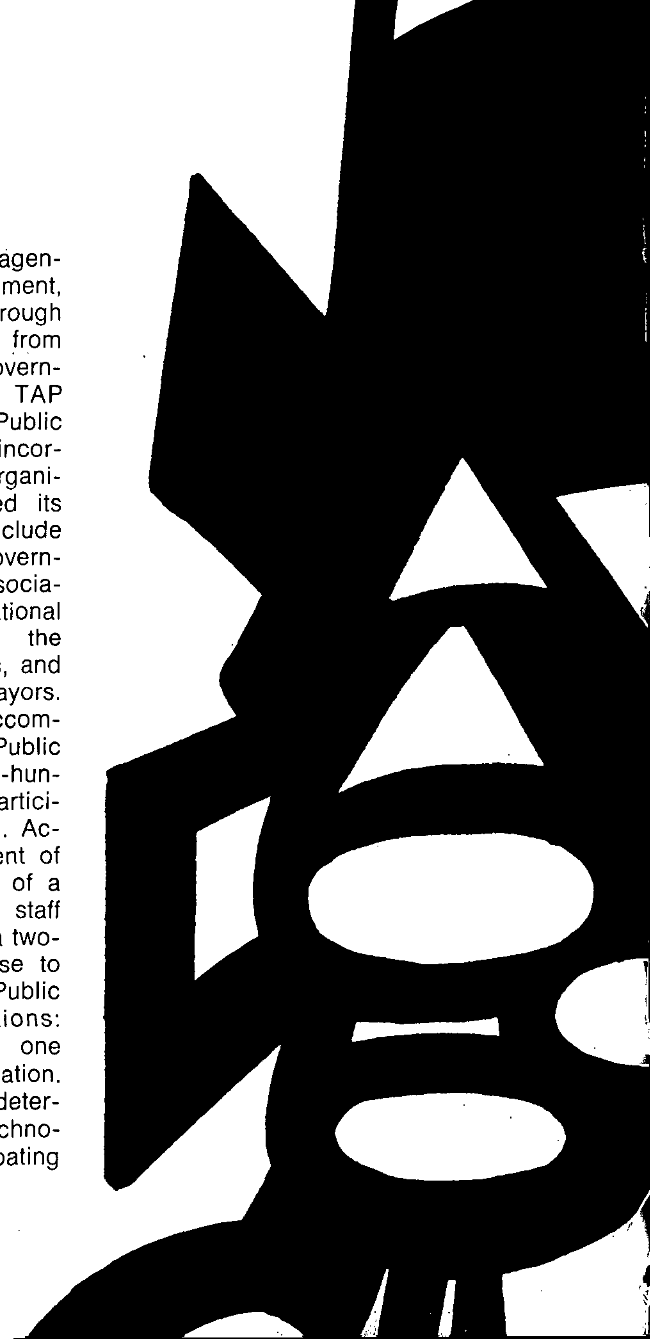
We also appreciate the support and interest of Mark E. Keane and William Besuden, Executive Director and Assistant Executive Director, respectively, of the International City Management Association.

Executive Summary

In the fall of 1970 a program aimed at helping local governments improve the productivity and quality of their services through the application of existing technologies was initiated by the International City Management Association. At approximately the same time, the National Aeronautics and Space Administration's Technology Utilization Office began a joint program with the Technology Application Program (TAP) of the International City Management Association to fulfill a more specific objective: the application of aerospace technologies and expertise to the solution of selected municipal problems. As indicated in the following pages, the two organizations have worked closely together and have made significant progress toward fulfilling their objective.

By the end of 1971, it became clear that there was an urgent and pressing need for the activities provided by TAP. It also became clear that the organization could be adequately funded through agencies of the federal government, private foundations, and through annual subscription fees from city, county, and state governments. Accordingly, TAP changed its name to Public Technology and became incorporated as a non-profit organization. It also broadened its base of sponsorship to include the Council of State Governments, the National Association of Counties, the National Governors' Conference, the National League of Cities, and the U.S. Conference of Mayors.

As a first step toward accomplishing its objective, Public Technology invited one-hundred municipalities to participate in the joint program. Acceptance required payment of $500 and a commitment of a half man-year of senior staff time from each city over a two-year period. The response to this offer far exceeded Public Technology's expectations: seventy-nine cities and one county accepted the invitation. The second step was to determine the most urgent technological needs of participating



cities. A three-day conference was held at Kennedy Space Center during which city administrators were introduced to selected technologies developed by NASA and to techniques for technology transfer. They also were trained in workshops to specify at the appropriate level of detail the technological needs of their cities.

Three months later, the participating cities responded with nearly five hundred problem statements in law enforcement, fire protection, public works, traffic safety and control, solid and liquid waste management, water treatment, health care, communications, data processing, and management science. This list of specific urban technological needs represented a major achievement of the program. While city administrators are intimately aware of their problems, they rarely, if ever, have had opportunities to express them to the technical community. Nor are they particularly accustomed to formulating their needs in technical terms at a level of specificity to which highly technical engineers might relate. The excellent quality and number of responses indicated anticipation on the part of the cities that technology indeed could help solve specific local problems. It also indicated their desire and determination to define their own needs, rather than continuing to rely on consultants and vendors.

The problem statements received from the cities were classified and analyzed. A committee representing the participating cities, The National Coordinating Committee, selected forty-three specific problems which most urgently needed solutions in the greatest number of cities. Of the forty-three problems, NASA then selected fifteen that they considered to have the highest probability of rapid solution through existing NASA technology and capability. At three regional meetings, the fifteen problems were ranked in order of priority by the participating cities. The National Coordinating Committee reconciled minor differences in regional priorities and selected six problems for immediate investigation. Each of the six problems and its status at the end of 1971 is presented below in order of priority:

Self-Contained Breathing Apparatus for Firemen. Alternative approaches to developing a lighter weight, less bulky, longer duration breathing apparatus were examined by Manned Spacecraft Center (MSC). Specifications for a lightweight compressed air tank, regulator, harness, and mask, as well as a compressor station have been written by MSC. A tank development contract has been awarded and remaining contracts will be awarded shortly. A User Design Committee, representing user expertise from various viewpoints, has reviewed, evaluated, and approved the design specifications and will review prototype development, testing, and demonstration. Prototypes are expected to be available for demonstration in selected cities in 1973.

Short-Range Communication Systems. This problem applies to both law enforcement and fire protection situations. However, it appears that police and fire requirements are not the same. We are attempting to isolate and identify these differences more precisely. New products under development or commercially available are being evaluated. Where cities have tested or are using advanced equipment, their experience is being reviewed. During the early part of 1972, we will determine whether existing equipment meets the urban requirements and decide whether a new development project is required. In the case of communication equipment for firemen, such a project would be closely coordinated with the breathing apparatus project and the protective clothing project described below.

Pavement Marking. Recent developments in pavement marking materials and machines have been reviewed. No systems meet all the specified requirements, but several devices currently under evaluation appear to meet most of the specifications. Representatives from NASA and Public Technology will be attending equipment demonstrations in the near future. If these new techniques

for pavement marking appear to meet the needs of participating cities, the necessary equipment will be delivered to selected cities for testing and evaluation.

Protective Clothing for Firemen. Public Technology and NASA are coordinating a firesuit development project at the Manned Spacecraft Center. NASA's technicians have completed materials evaluation and prototype design. Contracts have been awarded to private industry for the fabrication of twenty-one sets of garments. These garments include structural and proximity suits, caps, gloves and boots. Five of the demonstration sites will be in cities which are participating in this program: New York City, Washington, D.C., Milwaukee, Los Angeles, and Wheeling, West Virginia. The garments are expected to be available for demonstration in 1972. The breathing apparatus User Design Committee is also following the progress of this project.

Underground Pipe and Conduit Locator. A User Design Committee, representing participating cities, met in July of 1971 with engineers from

NASA's Marshall Space Flight Center in Huntsville. Various approaches to the problem were suggested to the User Design Committee. One of the most promising approaches is a downward-looking radar system being investigated by the NASA engineers for its technical feasibility. The engineers have completed a preliminary investigation and have indicated that this approach appears to meet the urban requirements and have proposed designing, building, and testing a prototype unit.

Automatic Fire Hose Flow Regulator. In July of 1971, a User Design Committee met with engineers at NASA's Lewis Research Center. Based on the results of this meeting, and a more intensive review of previous attempts at automating the pumper, alternative design concepts now are being developed. These design concepts will be evaluated for technical and economic feasibility.

Other problems specified by cities participating in the NASA project are being evaluated. Decisions will be made during 1972 to determine whether aerospace technologies can help solve these problems. The experience gained in this program to date has led Public Technology to conclude that:

- the needs and opportunities for applying technology to municipal problems are numerous,
- even small technological changes can have significant impact on the productivity and quality of urban services,
- existing technical resources and capabilities are capable of solving the most immediate problems,
- successful mechanisms can be developed for matching needs with capabilities,
- successful matching of needs with capabilities depends heavily on continuous participation and commitment of the user,
- standard specifications can be written to meet the needs of a broad cross-section of municipalities,
- successful delivery of technology will require aggregation of the urban market to encourage industry to invest its research and development funds in products for local and state governments, and
- local and state governments, public interest groups, commercial organizations, trade associations, and federal agencies, are becoming convinced that existing technology can be applied effectively to help solve some of the problems of local and state governments.

The objective of the first year program — to determine the feasibility of applying aerospace technologies to the solution of municipal problems— has been demonstrated. Technology clearly can help solve urban problems.

Public Technology's second year program will concentrate on refining the mechanisms for technology transfer. New products will be developed, tested, delivered to the cities, and used to improve local and state government services. The local and state government market will be aggregated for industry. An effective information exchange mechanism will be developed. And the benefits of technology finally will begin to find their way to city hall.

TABLE OF CONTENTS

Executive Summary ii

Public Technology: Its Objectives and Activities 2

Public Technology/National Aeronautics and Space Administration Technology Application Program 7

- Problem Identification and Selection 8
- Status and Plans of Problems 12
- NASA Technologies 24

Program Objectives and Conclusions 26

Appendices

- Participating Jurisdictions 28
- National Coordinating Committee 28
- Top Priority Urban Problems 29
- Problem Priorities by Region 36
- User Design Committees 38
- Technology Application Methodology 39

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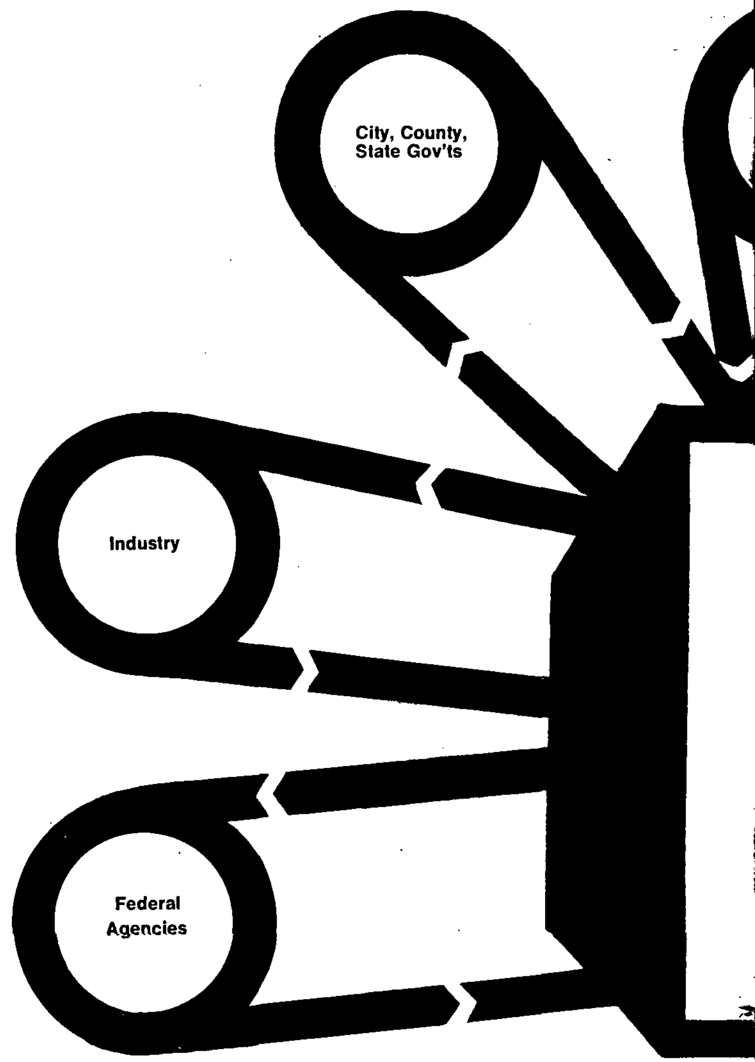
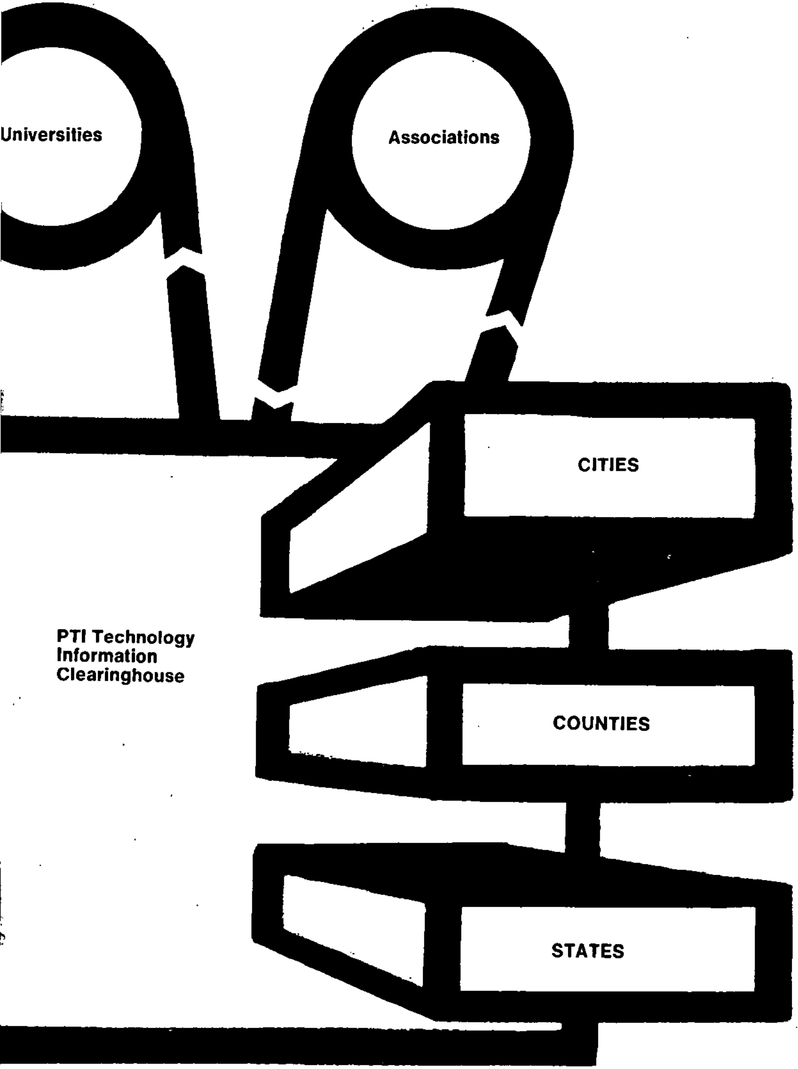
Public Technology: Its Objectives and Activities

Cities are acutely aware that they must increase the productivity of their urban services. In many cases, the quality of the services provided is not improving and may be deteriorating, while the cost of providing these services is soaring. Cities are also becoming aware that there are two major routes to increasing productivity: new technology and better management. Many of them firmly believe that the vast amount of the research and development conducted over the past several decades to meet the nation's space and national security missions has yielded new technologies which should be of benefit to their problems. They are frustrated by their inaccessibility to these new technologies. Generally, the industries currently servicing the municipal market are not known for their ability or willingness to introduce innovative technologies. Consequently, there are numerous needs and opportunities to apply technology to the urban sector. On the other hand, the scientific and technological resources and capabilities in this country are surpassed by none. The question is: how can these resources be matched with the needs?

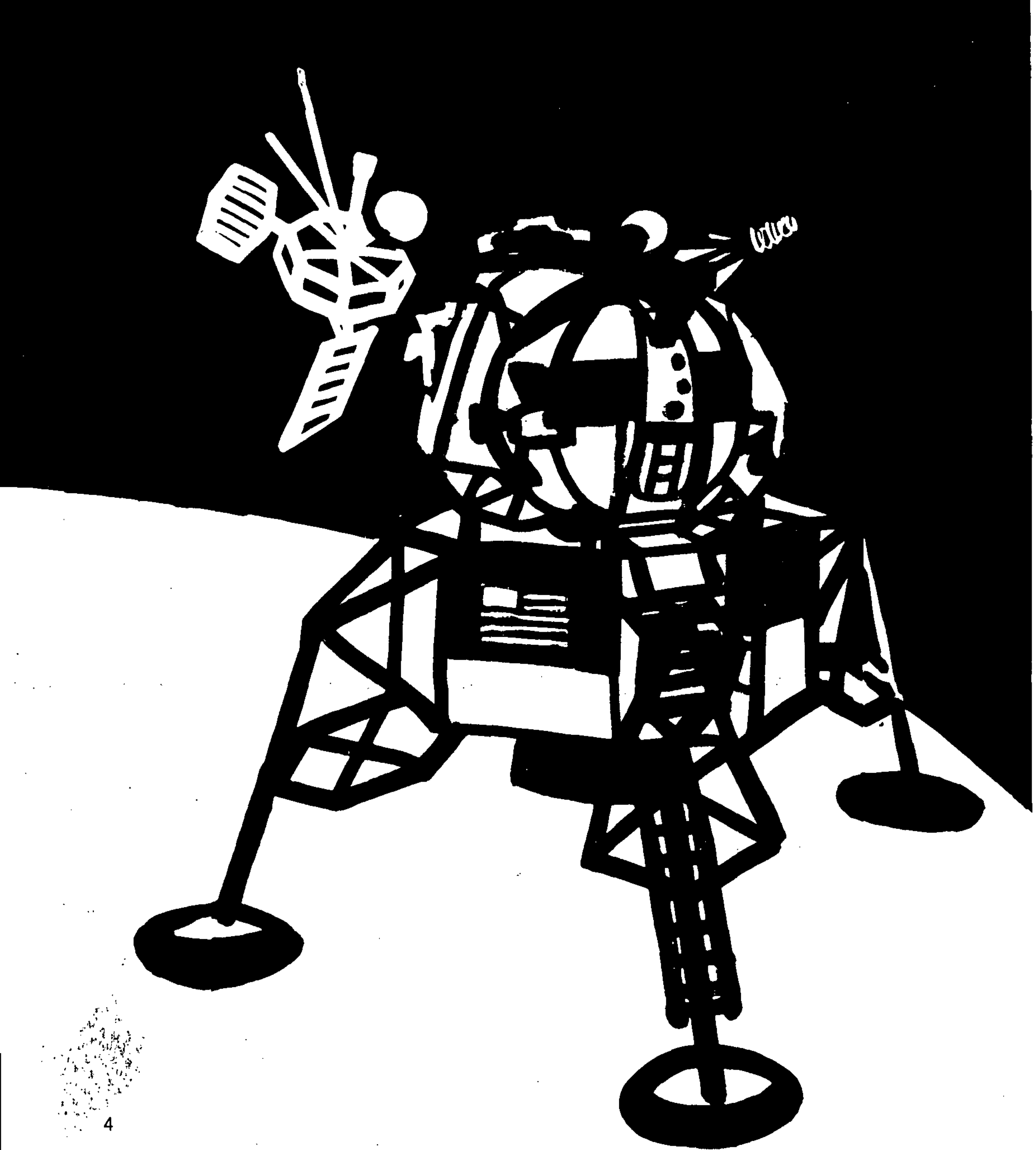




Public Technology, a non-profit, tax exempt organization, was created specifically to match technical resources with local and state government needs to provide a mechanism for the delivery of improved products and services. The organization is sponsored by six major public interest groups representing local and state governments: Council of State Governments, International City Management Association, National Association of Counties, National Governors' Conference, National League of Cities, and U.S. Conference of Mayors.

Objectives: Public Technology acts as a catalyst in the development of improved products and services for local and state governments. The organization accomplishes its objectives by providing a communication bridge between public users and industrial producers. It identifies city, county, and state needs susceptible to technological solutions; helps develop realistic solutions; and assures the widest possible dissemination and utilization of these solutions. Its major activities include:

- *Initiation of research* and development on behalf of its members.
- Development of practical solutions to problems common to local and state governments.
- Development of transferable performance and cost specifications for hardware and software widely utilized by local and state governments.
- Tests and demonstrations of new products and services that will help governments operate more effectively.
- Aggregation of local and state government markets to justify the development by the private sector of new or improved products and systems.
- Operation of an aggressive science and technology clearinghouse to inform members of improved products and services.
- Assistance and training for jurisdictions installing or using new procedures or products.
- Product evaluation of hardware and software with particular reference to requirements of local and state governments.



Public Technology is financed by local and state government memberships, federal government grants and contracts, and foundation grants.

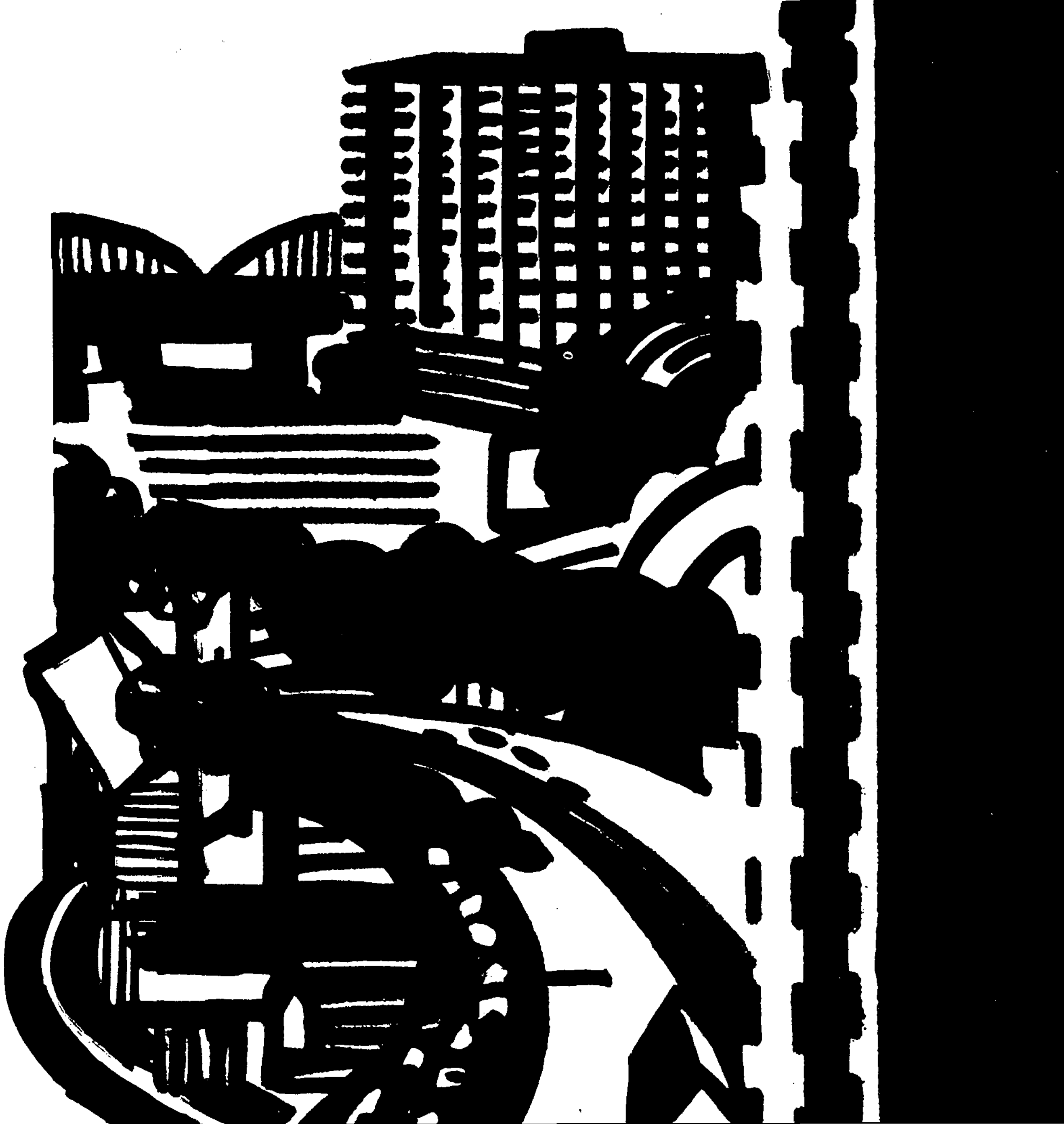
Activities: To achieve its objectives, Public Technology operates a variety of programs. It was through NASA that the first operational program pioneered the concept and demonstrated the viability of a technology application program for local and state governments, the Public Technology/NASA Technology Application Program. Based in part on the experience gained through the joint program with NASA, new programs have been initiated. Some of these new programs are described below:

Technology Clearinghouse. A technology clearinghouse is being developed to perform two functions: (1) to make available to municipal, county and state governments reports on currently available solutions to technical problems and (2) to convey the specific technical needs and requirements of member governments to federal agencies, universities and commercial organizations. First areas of investigation include fire services, drug control, solid waste disposal and data processing. Other areas will be added as the clearinghouse expands.

Development of a Transferable Facility Location Model. Initial work is being done to develop more efficient fire station locations using computerized analytic techniques. The technology used in this model will be adapted to locate libraries, mini-city halls, emergency ambulance centers, or any other service that is dependent upon a fixed geographical location and time and distance factors.

Regional Computer Systems. Efforts are underway to develop a transferable approach to the development and operation of regional computer systems.

Computer Software Exchange. Plans are being developed to define local and state government software needs and to



establish a national software inventory and exchange program.

Integrated Municipal Information System. Public Technology, in cooperation with the International City Management Association and the National League of Cities, is representing the nation's cities in a continuing review and evaluation of integrated municipal information systems. This project, known as USAC, is expected to produce transferable approaches, techniques, and computer programs that can be applied to other local governments that are interested in developing their own municipal information systems.

Solid Waste Technology. Public Technology is gathering information on all aspects of the solid waste management cycle including collection, disposal, recycling and reclamation. The organization already has investigated joint study proposals with several municipal jurisdictions, explored promising solid waste disposal technologies, and monitored applicable pilot projects. An effort is underway to develop a realistic decision-making model for local use in determining the best practical alternatives for collecting, recycling and disposing of solid waste.

Environmental Technology. Public Technology is coordinating a six-man local and state government committee to identify the information most urgently needed by administrators who are responsible for the application of environmental technology. This activity will lead to direct interaction between local and state officials and federal representatives to discuss solutions to specific, local environmental problems.

Product Evaluation. A program is underway to develop a process by which the products that state and local governments purchase may be evaluated. A reporting mechanism, perhaps along the lines of a "consumer report" for local and state governments, will evolve.

Public Technology/NASA Technology Application Program

A joint program between Public Technology and the National Aeronautics and Space Administration (NASA) Technology Utilization Office began in the fall of 1970. The initial objective of this program was to determine the feasibility of increasing the quality and efficiency of urban services such as fire protection, law enforcement, liquid and solid waste management, health and rescue services, traffic safety and control, through the application of aerospace technologies and capabilities.

The NASA Technology Utilization Office, under a mandate of the National Aeronautics and Space Act of 1958, operates numerous programs aimed at applying aerospace technology to the civilian sector. The joint program was initiated under the concept that Public Technology (formerly the International City Management Association's Technology Application Program) shall establish liaison with municipalities to identify and select significant but relatively short-term technological needs common to a number of cities. The two organizations shall work together to determine feasible technological approaches and to design applications engineering projects that specifically adapt existing technologies to municipal applications. Public Technology shall insure proper municipal inputs during prototype design, development, testing, demonstration, and problem identification. It shall also develop mechanisms to disseminate to the cities information about the projects.

In anticipation of about fifty favorable responses, a selected group of one hundred municipalities was invited to participate in the program. For a program of this nature to succeed, serious commitment on the part of the participating cities is required. Each city agreed to an obligation of $500 and approximately one-half man-year of high-level staff time to support the program. Seventy-nine cities and one metropolitan county with a total population of over 25 million people have joined this program. The participating jurisdictions are listed in the first appendix. This commitment represents a strong indication that these governments are sensitive to their technological needs and are willing to join in cost-sharing programs aimed at meeting those needs.

Problem Identification and Selection. A three-day working conference was conducted for the participating municipalities at Kennedy Space Center in October, 1970. Representatives from the cities were told about a wide range of aerospace technologies and their potential application to urban problems. They were briefed on technology transfer methodology as employed by the NASA Technology Applications Teams.[1] Finally, intensive workshops were held to train city administrators in the procedures for the identification, selection and specification of urban needs. The appropriate level of specificity is critical to the writing of problem statements. Problems which are stated too specifically usually presuppose a certain technological approach to the need, thereby excluding other alternatives which may be more promising. For problems stated too generally, it is difficult to relate specific relevant technologies. Therefore, problem statements should supply specific types and levels of information relevant to accurate specification of the need.[2]

At the conclusion of the conference, the city representatives were asked to go back to their respective cities and, with their department heads and other officials, identify, select and specify those problems of immediate importance to their city that might be solved through technology. The problems also need to show promise of relatively short-term solutions. A National Coordinating Committee, representing the participating cities, was selected by the conference attendees to review the problem statements. The members of the National Coordinating Committee are listed in the second appendix.

[1] Two NASA contractors in the Technology Application Team Program participated in the preparation and operation of the Cape Kennedy Conference: Abt Associates' Urban Development Application Team and The George Washington University's Technology Application Group. These two groups have provided substantial support throughout the first year of the joint program.

[2] The format used is described in William Clingman's *A Guideline for the Preparation of Problem Statements,* W. H. Clingman & Co., 1970.

Exhibit I
Problem Selections Results By Problem Area

Problem Area	Number of Problems Selected By: Cities	NCC*	NASA
Law Enforcement	106	7	1
Traffic Safety and Control	77	6	2
Fire Protection	56	10	5
Sewage Treatment and Disposal	34	3	0
Solid Waste Management	30	5	1
Utilities	29	5	3
Project Planning and Data Processing	28	0	0
Construction	21	0	0
Parks and Recreation	20	0	0
Public Safety—General	15	3	1
Health and Rescue Services	13	2	2
Miscellaneous	12	0	0
Air Pollution	11	0	0
Water Pollution	9	2	0
Noise Pollution	8	0	0
TOTALS	469	43	15

* National Coordinating Committee

Three months after the Cape Kennedy Conference, nearly five hundred (500) problem statements were received from the participating cities. These individual problem statements covered a broad range of areas, including fire protection, law enforcement, health and rescue services, solid and liquid waste management, water, air and noise pollution, traffic safety and control, utilities, program management and data processing, and construction. In January of 1971, the National Coordinating Committee met to review the problem statements and select the significant problems that were common to most participating cities, and that could be solved with existing technologies. The Committee selected forty-three problems; these are briefly described in the third appendix.

The forty-three priority problems were then reviewed by the NASA Technology Utilization Office and by selected contractors to determine to which problems aerospace technologies and capabilities could make the greatest contributions. Fifteen problems were selected on a basis of judgments about the extent of NASA's resources, whether extensive research and development programs are underway in other federal agencies, and whether commercial products not now marketed specifically to the cities appear to meet the urban requirements. The results of this two-stage screening process by problem area are given in Exhibit I.

For each of the fifteen problems, a problem statement that expressed the requirements submitted by the participating

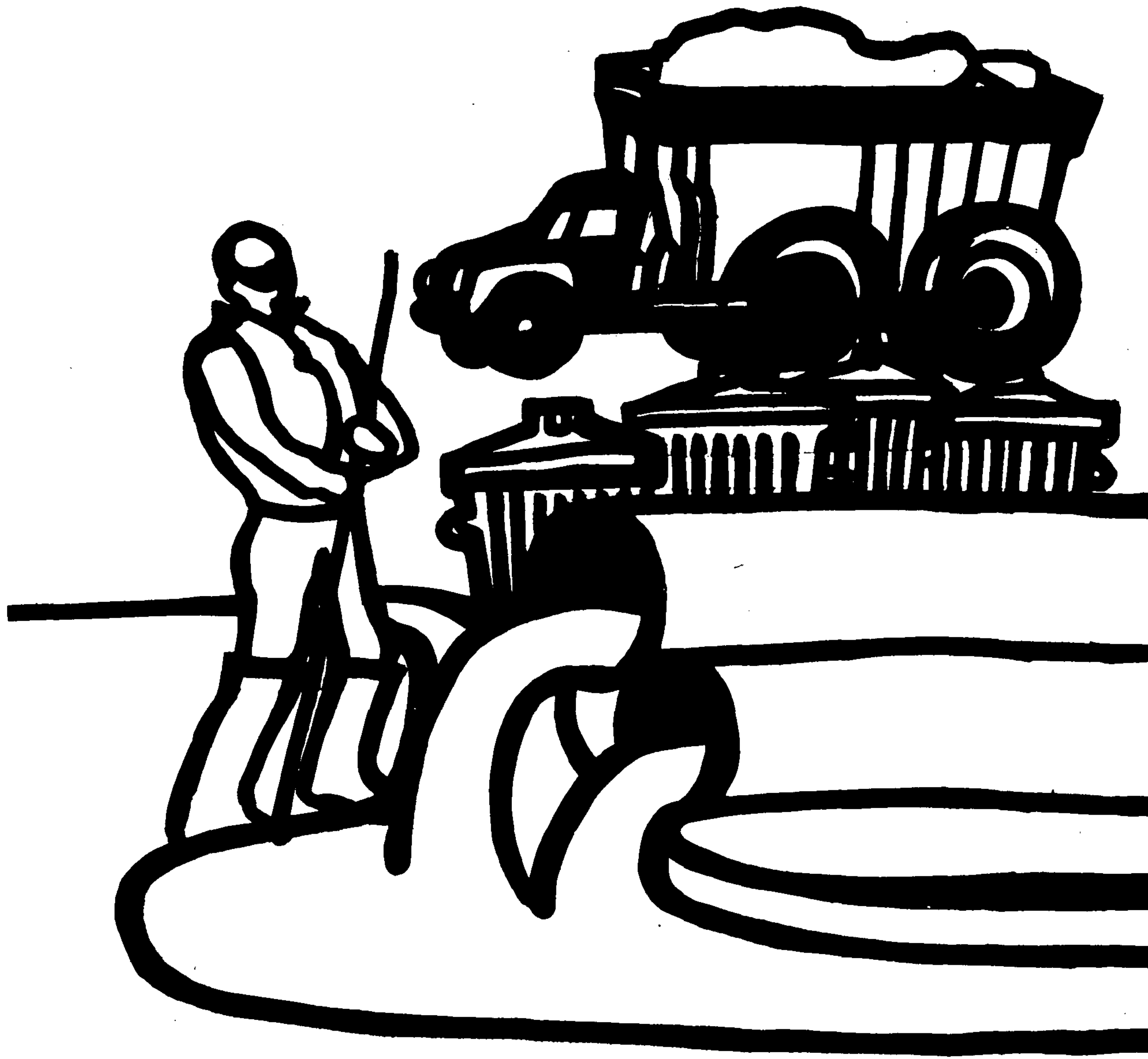


Exhibit II Problem Statement Example Underground Utility Locator

Need:
A simple, safe, reliable method of locating and identifying underground pipelines, conduits, cables, and service facilities.

Background:
Currently, most gas, sewer and water pipelines are placed underground and in relatively close proximity to one another. In the future, a large portion of the electrical utilities will also be placed underground and in the same general vicinity.

When breaks or other malfunctions occur in any of these underground utilities, there is a perplexing problem of determining which utilities are located where. The current practice is either to excavate on a trial and error basis or use a relatively unsophisticated metal detector. These methods are generally ineffective and may also result in damage to the utilities when the excavation is attempted.

It is also continually necessary to seek out and identify these buried utility lines in preparation for road work, repairs of the utilities, and/or all types of construction. The problem will continue to grow in magnitude. The job costs of engineering planning and field construction would be greatly lessened if it were possible to quickly and easily locate and identify buried service lines.

Most utility companies do not have accurate and precise records of their underground facilities, nor do they find it expedient to attempt to establish and maintain such records. The general practice is to rely upon "finding" the line in the field. Present methods of finding lines are chiefly by use of construction plans from which the line was built originally; although not necessarily in exactly the locations shown. Locations on these plans are generally verified by "potholing" in the streets. As a practical matter, the establishment and maintenance of an accurate set of underground records is almost an impossibility because of the prohibitive expense.

Constraints and Specifications:
1. Device should be able to locate utilities with ferrous or non-ferrous and metallic or non-metallic components, including clay sewer pipes and plastic pipes.
2. Device should be able to locate an object to about six inches in both horizontal and vertical planes (horizontal direction is most important.)
3. Device should be battery or field powered and operable and transportable with one man, or at most two.
4. Device should be able to work a minimum depth of ten feet.
5. The locator should be able to detect a conduit or pipe line underground, then to verify the nature of its contents. (Detection of pipe more important than detection of contents.)
6. The instrument must be suitable for all weather operation.
7. The instrumentation should also be capable of operating inside structures such as tunnels, pipe ways, buildings, or under bridges.
8. The instrumentation should be capable of being placed in storage without preparation other than cleanup and in turn should be capable of going into service immediately without much reassembly or preparation.
9. If possible, such instrumentation should be capable of detecting lines under water and also under ice and snow.
10. A weight of about 10 pounds would be reasonable for convenience to the operators although, if a two man crew were involved, each man could handle 10 pounds.
11. Cost would not be a very critical matter if successful instrumentation is developed since the economic value of this operation would be so great and the need for such an instrument so wide-spread.

cities was written by the Technology Applications Team at Abt Associates, Inc. An example of such a problem statement is given in Exhibit II. A survey was developed to obtain specific information from participating cities about whether the problem statement adequately represented their requirements; what equipment, systems or procedures the cities now use or have used; in what way the existing products do not meet their requirements; and what their annual costs are for new equipment, operations and *maintenance.*

In addition, preliminary background information on each of the fifteen problems was collected by Abt Associates, Inc. This material provided information about the states-of-the-art of the technologies that would be applied to these selected problems.

Representatives of the participating cities were assembled again at three regional meetings held during February and March of 1971 at Anaheim, California, Washington, D.C., and Kansas City, Missouri. The information gathered on each of the fifteen problems was reviewed for the city representatives. After extensive discussions about the requirements indicated in the problem statements and the importance of the need, each region ranked the problems in order of priority. The results of the three regional meetings are provided in the fourth appendix. At the conclusion of each regional meeting, each city was requested to have the appropriate person complete the survey instrument for each of the fifteen problems for analysis by Public Technology.

In April, the National Coordi*nating Committee met again to* resolve minor differences in the regional priorities, taking into account the results of the municipal survey. The resultant priority ranking of the fifteen problems is given in Exhibit III. The meeting concluded with a decision to proceed immediately and focus on the top six problems.

Several important points should be noted about the problem identification, selection, and specification procedures. First is the overwhelming response of the cities to the opportunity to participate directly in specification and selection of their priority needs. Both the quality and quantity of the problem statements received from the cities indicate their interest and capability to adequately express their needs given guidelines and mechanisms within which to respond. The 500 problem statements represent a major achievement of the program. Second, mechanisms were developed to involve city administrators and operating departments in all phases of the program. The success of this program depends heavily on the commitment of the cities and their constant participation. *Third, problem selection was* focused on the significance of the problem, commonality of problems to many cities, feasibility of solutions using aerospace technologies and capabilities, and potential early benefits. The program is now beginning to consider long-term needs, although initially the feasibility of the concept of applying technology to municipal needs was shown by concentrating on those problems where technological solutions already exist. The fourth important point learned is that cities can reach agreement on common requirements for solution of their problems.

Exhibit III
Fifteen Problems In Order Of Priority

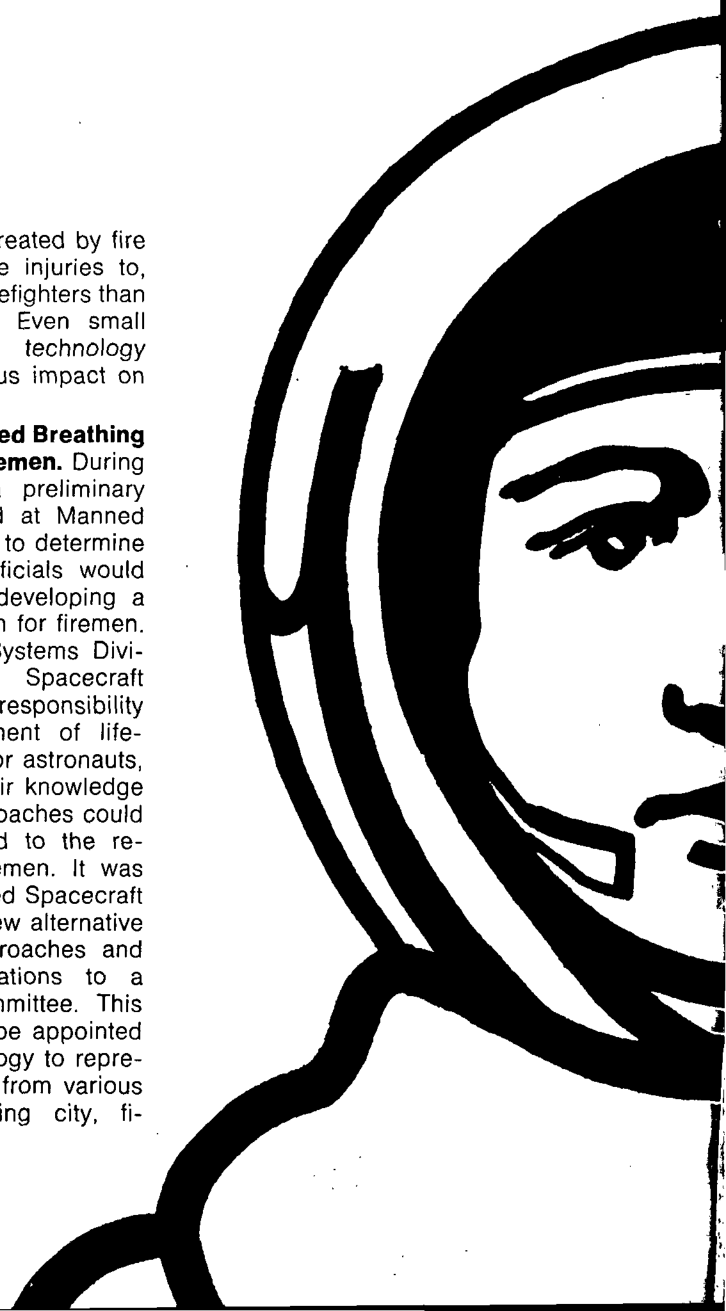
1. Self-Contained Breathing Apparatus for Firemen
2. Short-Range Communication Systems
3. Pavement Marking
4. Protective Clothing for Firemen
5. Underground Pipe and Conduit Locator
6. Automatic Fire Hose Flow Regulator
7. Command Control Center Design
8. Body Armor for Policemen
9. Toxic and Flammable Waste Disposal
10. Electrical Fault Detection
11. Portable Traffic Counter
12. New Fire Hose Materials and Couplings
13. Emergency Patient-Monitoring
14. High Voltage Power Transmission
15. Non-Emergency Patient-Monitoring

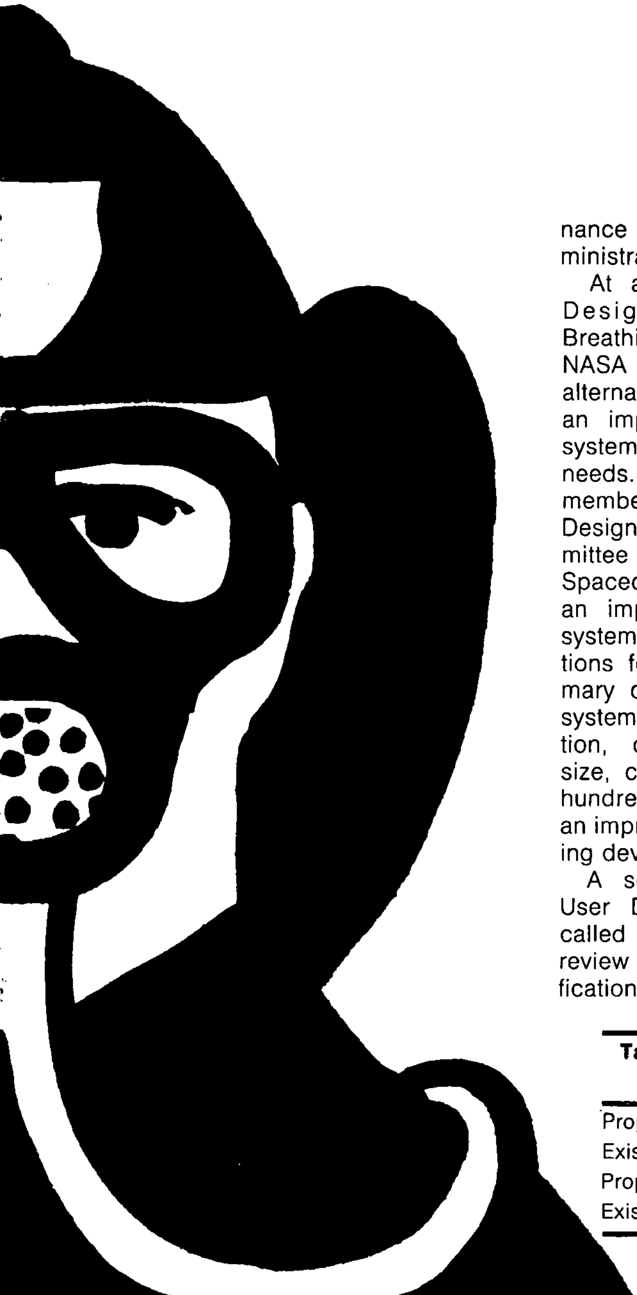
Status and Plans of Problems.

After six months of identifying, analyzing and selecting municipal problems, the National Coordinating Committee decided *that the remainder of the first* year's effort should focus on the first six of the fifteen selected problems. Most of the effort on this program so far has concentrated on the top six, although progress has been made on some of the other problems. The status and plans for each of the fifteen problems is presented in order of priority below. A brief description of all forty-three priority problems is given in the third appendix.

One-third of the fifteen problems and two-thirds of the top six problems are in the fire protection area, which indicates that there is a need to increase the effectiveness of fire-fighting equipment and methods, and to increase the safety of fire-fighting. Fire-fighting is now America's most hazardous occupation. The combined effect of heat, oxygen deficiency, smoke and toxic gases created by fire accounts for more injuries to, and fatalities of, firefighters than any other cause. Even small *improvements in technology* can have enormous impact on fire service.

1. Self-Contained Breathing Apparatus for Firemen. During April of 1971, a preliminary meeting was held at Manned Spacecraft Center to determine whether NASA officials would be interested in developing a life support system for firemen. Since the Crew Systems Division at Manned Spacecraft Center has the responsibility for the development of life-support systems for astronauts, it was felt that their knowledge of alternative approaches could be readily applied to the requirements of firemen. It was agreed that Manned Spacecraft Center would review alternative technological approaches and offer recommendations to a User Design Committee. This committee would be appointed by Public Technology to represent city interests from various viewpoints including city, fi-





nance and fire department administrators, and labor unions.

At a meeting of the User Design Committee for the Breathing Apparatus Project, NASA representatives reviewed alternatives and recommended an improved compressed air system to satisfy near-term needs. The fifth appendix lists members of the respective User Design Committees. The committee requested that Manned Spacecraft Center proceed with an improved compressed air system and develop specifications for the system. The primary criteria for an improved system were increased duration, decreased weight and size, cost not to exceed five-hundred dollars per unit, and an improved air depletion warning device.

A second meeting of the User Design Committee was called in October of 1971 to review the preliminary specifications of the system. The User Design Committee was divided on the benefits of various trade-offs between increased duration and decreased weight and bulk. Some felt that by significantly decreasing the weight and bulk without significantly increasing the duration would satisfy the need for improved breathing apparatus in eighty-five per cent of the fire situations. The increased comfort and ease of donning and duffing they felt out-weighed longer duration. Others felt that increased duration had higher priority than decreased weight and bulk.

Manned Spacecraft Center proposed a dual path development project which was approved by the User Design Committee. The two tank configurations are as follows: Type I tank would be a 60 standard cubic feet capacity, 6.5 inches in diameter by 18 inches long (excluding value) and would weigh 14 pounds. Type II tank would be 40 standard cubic feet, 5.25 inches in diameter by 18 inches long, and would weigh 9 pounds. A comparison to existing systems is given below.

Tank Type	Capacity Standard Cubic Feet	Size Inches	Weight Pounds
Proposed (Type I)	60	6.5 x 18	14
Existing	45	6.75 x 19.5	18
Proposed (Type II)	40	5.25 x 18	9
Existing	25	5.25 x 18.5	10

Contracts for the development of the tanks have been awarded. Prototypes will be available in 1972.

A nominal working pressure of 4000 pounds per square inch has been agreed upon, thus necessitating the development of a 4000 pounds per square inch compressor station. The specifications for the compressor station are nearly completed. The specifications for the regulator, harness and mask development have been completed. Contracts for both the compressor station development and development of the regulators, harness and mask will be awarded early in 1972. Systems prototypes should be available for demonstration in selected cities in 1973.

2. Short-Range Communication Systems. Literature searches have been made with-

in both NASA's and the Defense Department's unclassified data base to identify equipment and technology that could be of *value in solving the need for* municipal short-range communications systems. In addition, Public Technology's staff members have met with manufacturers of communications equipment to discuss their products. Informal arrangements have been made with several of these companies to provide models for test and evaluation both by NASA and the municipal users. A review and evaluation of the manufacturer's specifications will be made by a User Design Committee and NASA technical personnel. Following a review of NASA's advanced communications technology program, specific plans for test and evaluation of the manufacturer's equipment will be made and tests conducted in selected cities. A preliminary report on the state-of-the-art has been distributed to NASA by Public Technology.

While this problem applies to fire protection, law enforcement and other service areas, it is becoming apparent that the *requirements in each case are* not entirely the same. In particular, communication requirements for firemen have been seriously neglected by industry.

3. Pavement Marking. Research and development in pavement marking materials and methods has been undertaken by the federal government, by states, and by industry. A search of the NASA and Department of Defense literature, as well as the literature of other government agencies, indicates that this problem may soon be solved by the private sector at least for highway and airport applications. However, the cities' need for a marking material that can be easily removed is not likely to be met by industry in the near future.

In particular, Public Technology is reviewing the products of firms which have *developed epoxy resins and curing* agents that can be heated and sprayed like paint. These materials have excellent adhesion properties and are resistant to abrasion, salt, rubber, gasoline and oils. Reflectivity is considerably improved over the paint and glass beads combi*nation now in common use. The* decision on whether or not to initiate a development project will depend on the importance and feasibility of easily removing the marking materials.

4. Protective Clothing for Firemen. Public Technology is participating in a firesuit development project underway at the Manned Spacecraft Center. The program is well into Phase II of a three-phase program. Phase I consists of conceptual prototype design, fabrication of selected design concepts, and evaluation of prototypes. Phase II consists of modification based on prototype evaluation, manufacture of modified designs, initial distribution of fire-fighters garments, and evaluation based on use in fire-fighting situations. Phase III consists of summarizing results of user evaluations, remanufacture and wider-scale distribution, evaluation of results, and generation of *final* specifications.

A contract has been awarded for the manufacture of twenty-one sets of garments for delivery in 1972. Five of the test sites will be cities participating in the Public Technology/NASA Technology Application Program: New York City, Washington, D.C., Los Angeles, Milwaukee, and Wheeling, West Virginia. The garments being developed include both structural and proximity suits, caps, gloves and boots.

The Breathing Apparatus User Design Committee is reviewing this project to encourage compatibility between the breathing apparatus and the protective clothing.

5. Underground Pipe and Conduit Locator. A comprehensive literature search was made at the NASA Scientific and Technical Information Facility which included the Defense Department's unclassified data base. In addition, technical personnel of the NASA-sponsored Urban Development Applications Project at Abt Associates, Inc. conducted an analysis of commercially-available products. A report on equipment now in use by cities for pipe and cable detection was prepared for a July, 1971 meeting at Marshall Space Flight Center of the User Design Committee. Discussions between the committee and Marshall Space Flight's engineers led to a better understanding of the cities' requirements and an evaluation of alternative technological approaches. The group concluded that a downward-looking radar system seemed to be the most promising approach given the state of existing technology. Later, this conclusion was confirmed by Bell Telephone Laboratories, whose study had investigated all plausible methods of detecting underground targets. While radar will not detect all underground targets to a depth of ten feet in all soil and surface conditions, it nevertheless represents a significant advance over systems currently in use.

Several radar developments for locating underground targets are under consideration. Marshall Space Flight Center's engineers met with army personnel at Fort Belvoir, Virginia to discuss their radar systems underground target detection. For obvious reasons, their applications are classified. Arrangements for a second trip to Fort Belvoir to test the equipment for city applications is being planned.

A New England firm, which has developed a similar but not identical system, now provides underground detection services both for geophysical and utility line applications. This system is also being evaluated.

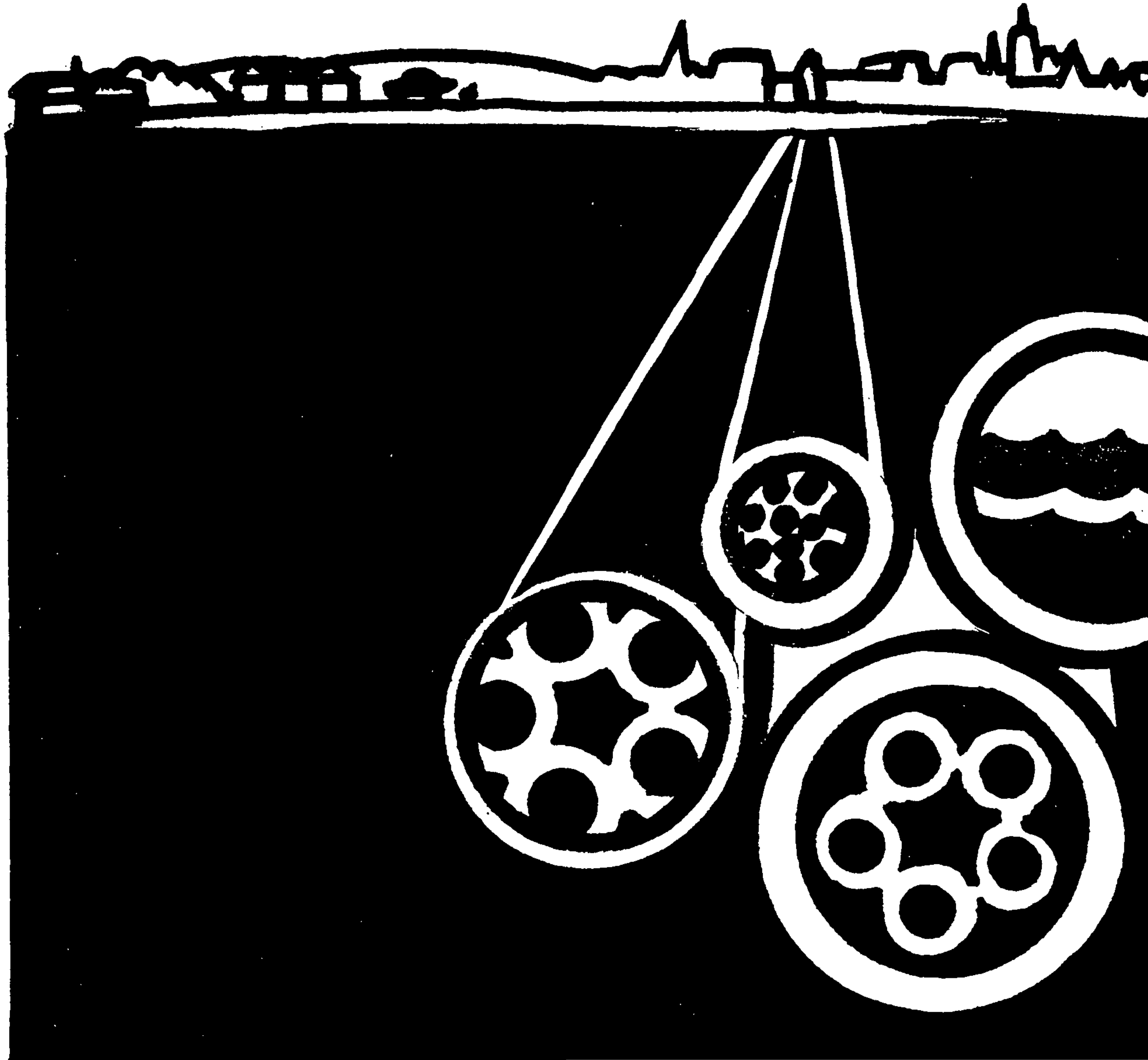
A second meeting of the User Design Committee will review these two systems and decide whether downward-looking radar has enough potential to warrant an applications engineering project.

6. Automatic Fire Hose Flow Regulator. In preparation for a meeting with the User Design Committee, the Technology Application Team at Abt Associates, Inc. developed preliminary alternatives to manual control of flow and pressure at the nozzle. Meeting at Lewis Research Center in July, 1971, the project's User Design Committee agreed that the problem was more properly defined as flow regulation rather than pressure regulation and that automatic flow regulators for certain applications existed commercially. Since the system components are commercially available, Lewis Research Center suggested that it was more appropriate for the applications engineering to be done by industry or university.

Subsequent discussions with technical personnel in industry, fire departments, and universities who have considered various alternatives to manual control of the pumper led to a fuller understanding of the complexity of the problem. Public Technology plans to bring NASA engineers together with the user expertise to evaluate several design concepts which resulted from these meetings.

Because of the central role of the pumper in fire-fighting operations, there is considerable resistance to its change. Yet a sufficient number of fire departments feel that automation of the pumper is one of the more important areas where technology can have significant benefits.

7. Command Control Center Design. A preliminary literature search has been completed. An initial report based on information obtained from the Law Enforcement Assistance Administration, the Defense Department, and NASA has been prepared and distrib-



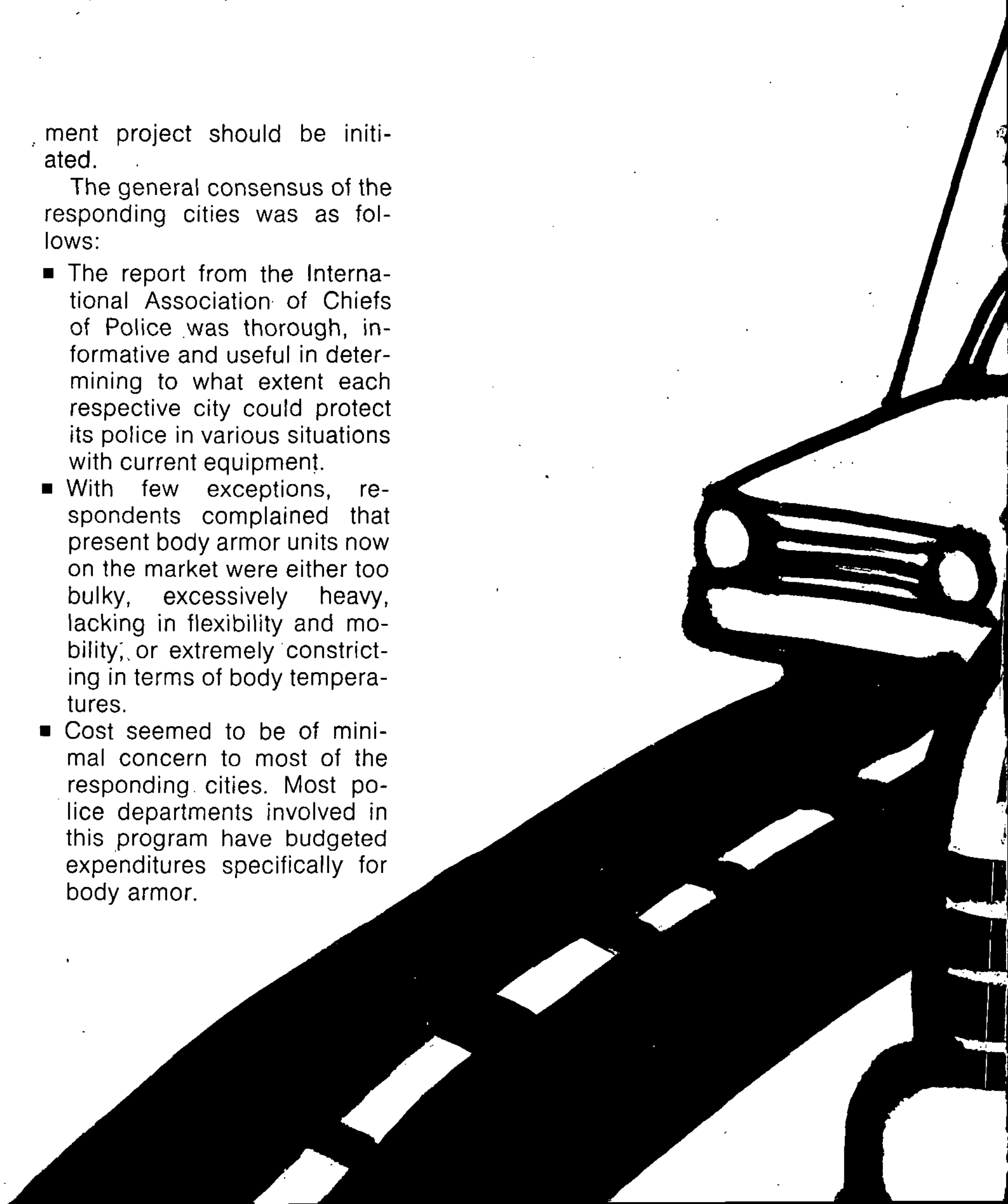
uted to NASA by the George Washington University Technology Applications Group. Next, a User Design Committee will be established. Discussions to date have shown that there is a need for standard design specifications for a command control center to meet the requirements of medium-sized cities.

Command control systems are needed primarily by the public safety agencies: law enforcement, fire protection, and rescue squads for efficient responses to emergency calls.

8. Body Armor for Policemen. A literature search was conducted to ascertain the state-of-the-art in protective armor. In addition to searching NASA and the Department of Defense sources, information was gathered from other federal agencies and industry. In December of 1971, correspondence was sent out to thirty-six cities, all of whom had initially specified the need for better protective body armor for policemen. Included with each letter was a copy of a comprehensive report published by the Police Weapons Center of the International Association of Chiefs of Police and written by Leonard C. Miller. This report detailed the test results of twenty-three commercially available body armor units which were ballistically tested. Each of the thirty-six municipalities was asked by Public Technology to review the report and to inform Public Technology whether any of the commercial systems adequately meet their needs or if not, what specifically requires improvement. Their comments will be used in determining whether a development project should be initiated.

The general consensus of the responding cities was as follows:

- The report from the International Association of Chiefs of Police was thorough, informative and useful in determining to what extent each respective city could protect its police in various situations with current equipment.
- With few exceptions, respondents complained that present body armor units now on the market were either too bulky, excessively heavy, lacking in flexibility and mobility, or extremely constricting in terms of body temperatures.
- Cost seemed to be of minimal concern to most of the responding cities. Most police departments involved in this program have budgeted expenditures specifically for body armor.

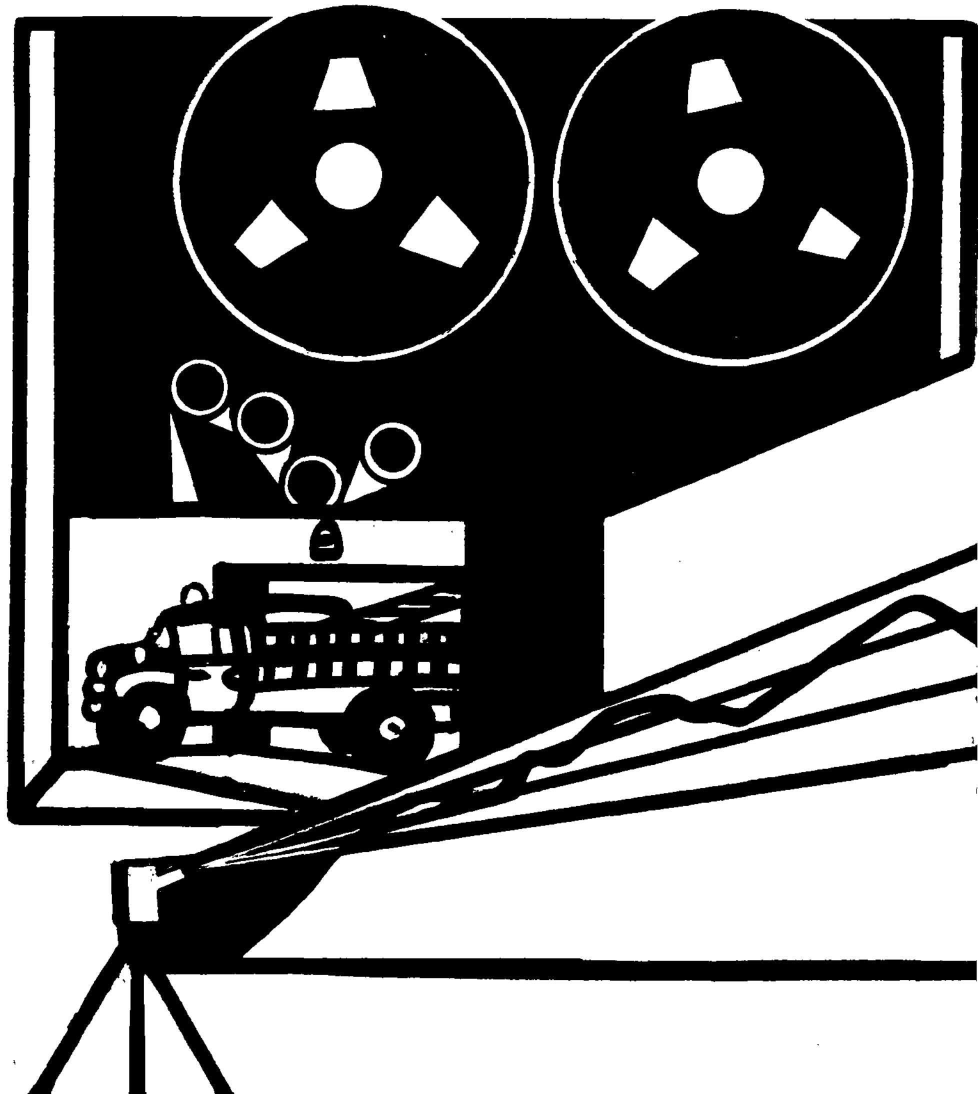


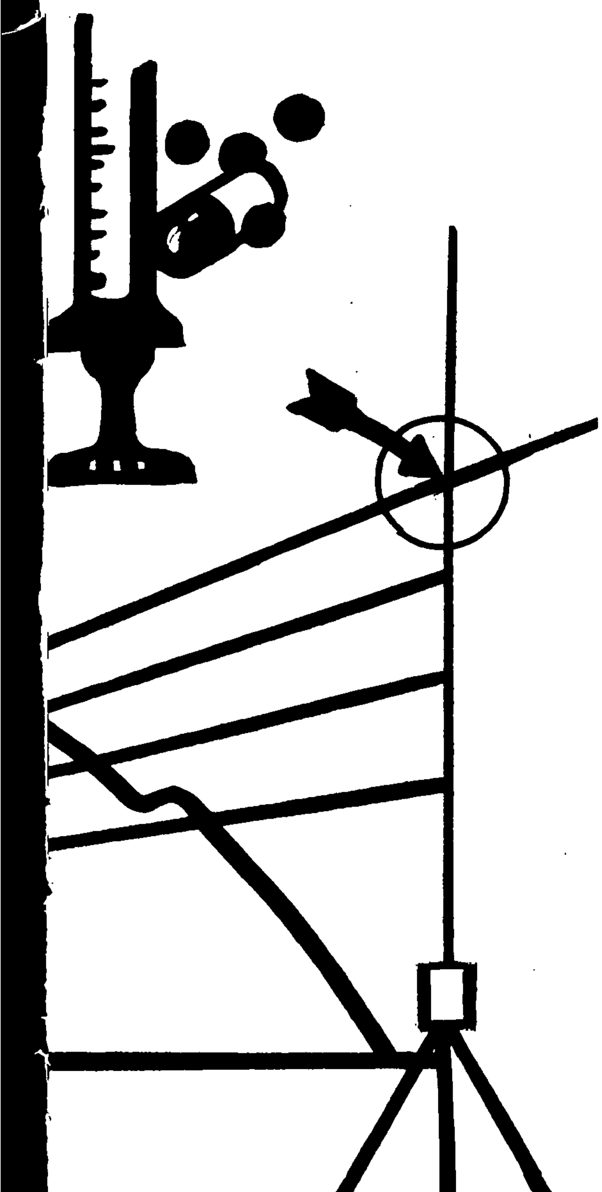
- Many cities expressed the opinion that a code of specifications and standard requirements should be developed to identify the most important characteristics and solutions sought in the area of protective armor.

9. Toxic and Flammable Waste Disposal. Pertinent investigations by several organizations currently are underway. The Environmental Protection Agency has a mandate under the Resource Recovery Act of 1970 to submit to Congress a comprehensive report and plan for the creation of a system of national disposal sites for the storage and disposal of hazardous wastes, including radioacitve, toxic chemical, biological and other wastes which may endanger public health or welfare. This report will include a list of materials considered to be hazardous; current methods of disposal for these materials; recommended improved methods of reduction, neutralization, recovery or disposal of such materials; an inventory of possible sites; and an estimate of the cost of developing and maintaining the sites.

The State of Pennsylvania has proposed standards for the disposal of hazardous solid substances. They spell out specifically how hazardous waste *should be handled during collection*, transportation, processing and disposal.

In view of these and other





similar efforts, the Public Technology/NASA program is investigating the need for specific instrumentation to monitor for toxic and pathogenic materials in water and sewage treatment plants. Little or no equipment presently exist for monitoring water quality parameters such as the presence of petroleum, heavy metals, bacteria, phosphates, pesticides, and other toxic materials.

10. Electrical Fault Detection. Plans are underway to conduct a comprehensive survey of commercially available equipment in this area, determine the feasibility of alternative technological approaches to the problem, and decide whether a development project is required.

11. Portable Traffic Counter. Plans also are underway to survey available commercial products, determine the feasibility of alternative technological approaches, then decide whether new product development is needed.

12. Fire Hose Materials and Couplers. A search of the NASA information system is in progress. In addition, commercial developments, including those in other countries, are being reviewed. At present, it is not clear whether existing technologies can provide significant improvements over commercially available products.

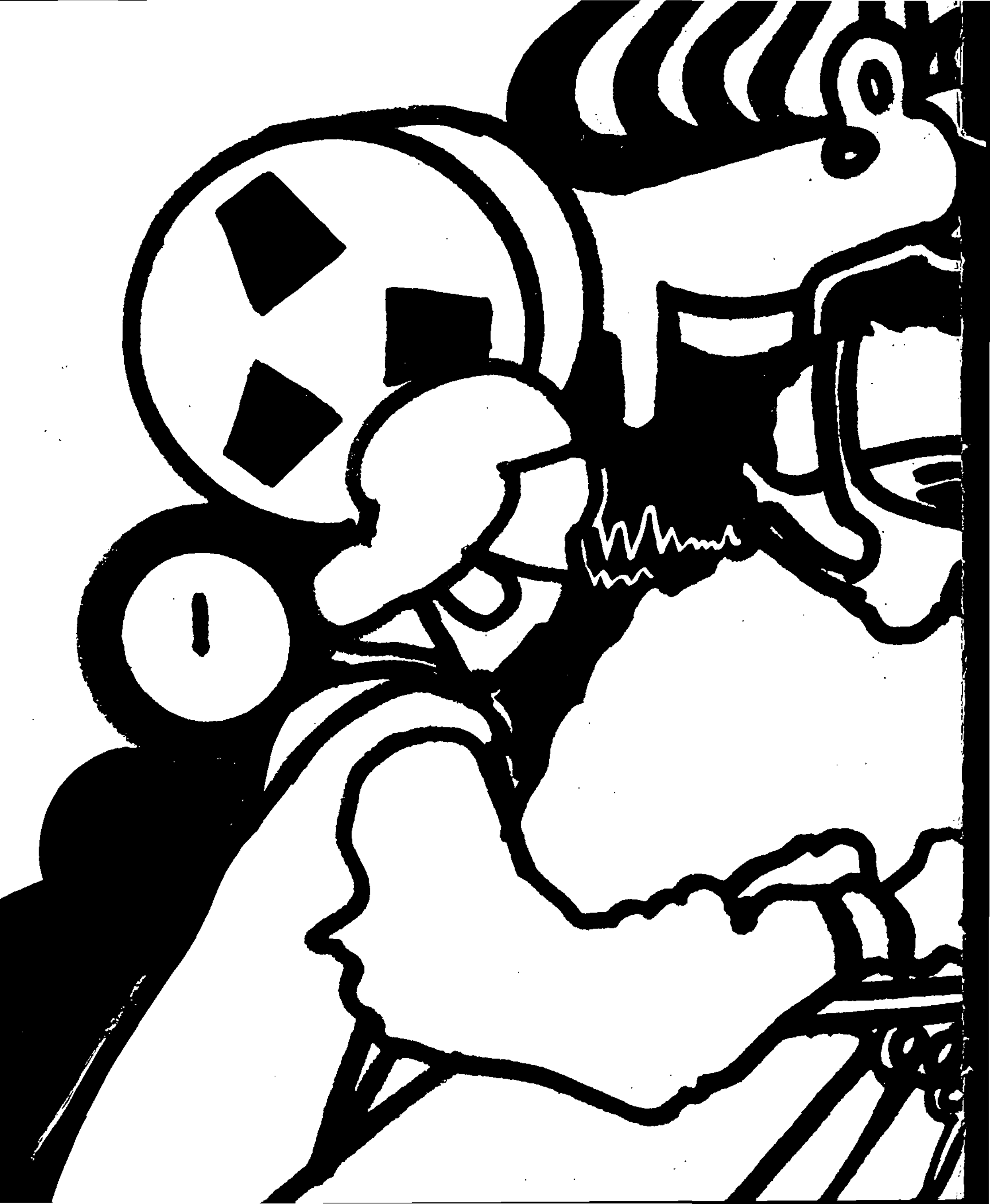
13. Emergency Patient Monitoring. A review of NASA's contributions to the field of patient monitoring was conducted by Abt Associates Inc., and documented in a report entitled *Applications of Aerospace Technology in Industry: Patient Monitoring,* (Abt Associates, Inc., Cambridge, 1971). This report describes many of the technologies developed to enable astronauts' physiological functions to be monitored remotely.

In addition, a preliminary survey of advanced emergency medical services employing patient monitoring and telemetry equipment was conducted. A brief review of fourteen different systems indicated, (1) that there is a tremendous need to supply information about these systems to other municipalities to help them make implementation decisions, (2) certain aspects of the system, such as the rescue vehicle instrumentation, and paramedical personnel training procedures—can be standardized, and (3) there is considerable opportunity for technical improvements in emergency mobile medical systems using patient monitoring equipment.

Plans to design an emergency mobile medical system which uses aerospace technologies and developments are being considered.

14. High Voltage Power Transmission. A survey of current research and development programs now underway in this area is being conducted, and will be submitted to the participating cities. No further activity is anticipated in this program.

15. Non-Emergency Patient Monitoring. Plans are underway to survey existing systems. The state-of-the-art of these systems will be compared with the state-of-the-art of NASA technology to determine whether improvements can be made.



Summary. Of the *top six* problems, two have development projects underway, two have development projects *being designed*, and two have commercial equipment being evaluated.

Two major points are worthy of note here: *first*, the "*gap*" between the urban requirements and commercial product performance characteristics provides an *excellent* guide to identifying opportunities for technological improvements and to determine whether new developments are required. The sixth appendix provides a fuller description of the methodology used in the program. Second, the User Design Committees insure that new product developments adequately meet user requirements through participation in project design, development, testing and demonstration.

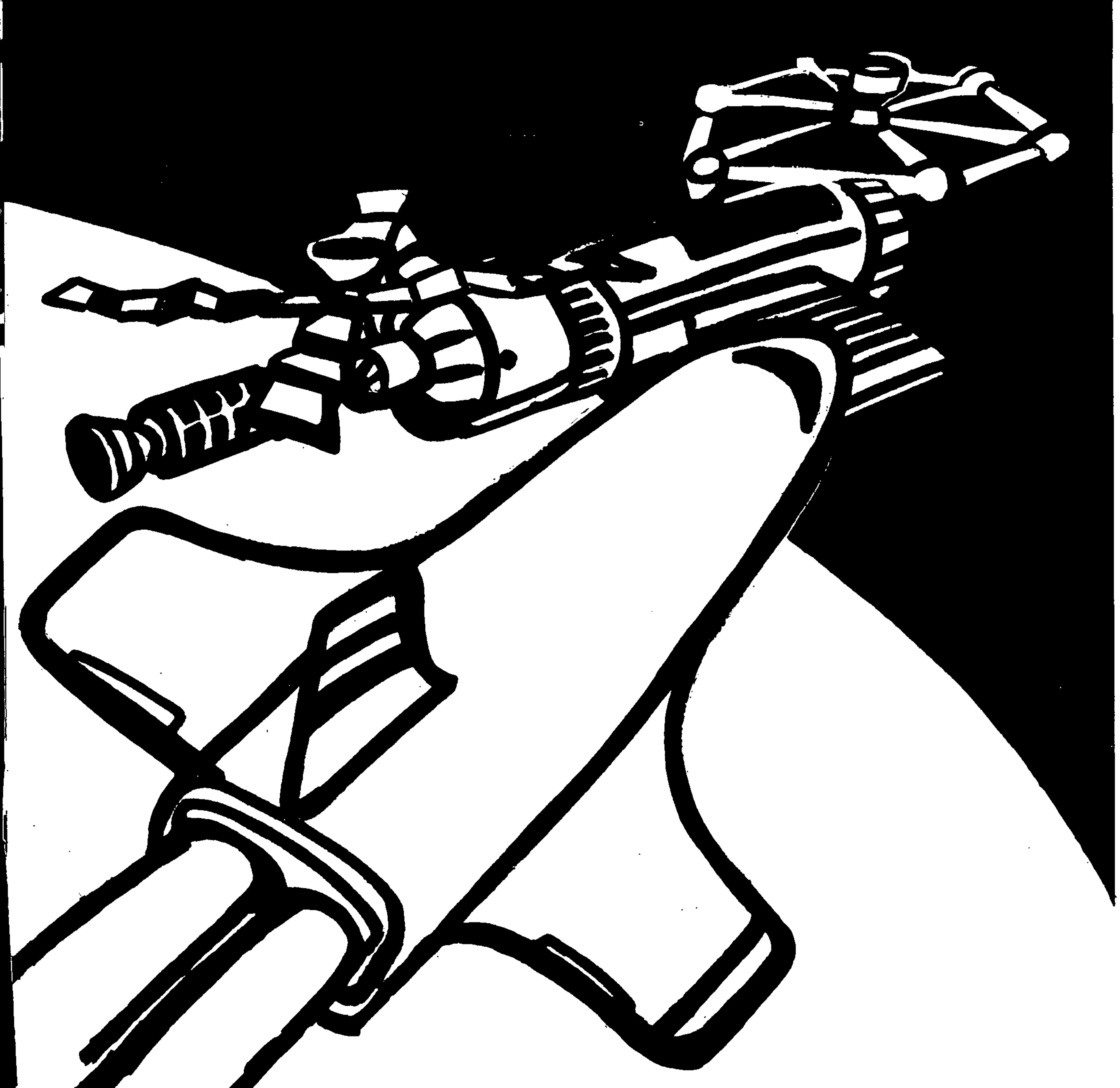
NASA Technologies. In addition to aerospace technologies and capabilities which are specifically relevant to the selected municipal problems, Public Technology in coordination with the NASA Technology Utilization Office and its other programs, identifies selected applications of aerospace technology which may also be of considerable interest to municipalities. Some of these projects are described below.

Street Patching Material. A thermoplastic material was originally developed by NASA in its search for a better rocket propellant binder. A NASA-sponsored project is underway at Stanford Research Institute to use this material for street patching. Other uses might include roofing, and coating for refuse in sanitary landfill operations. The material appears to have good tensile strength and resilience between −50° and 150° F. It is easily handled and may be applied over a wide range of temperatures. Additional advantages are that it easily incorporates shredded old tires as a filler and used crankcase oil as a constituent part.

Drug Detector. NASA has funded a project at Ames Research Center to develop a simple, rapid, reliable drug detector. The detector consists of a simple self-scanning spectrophotometer for use with column chromatography in the detection and identification of morphine in urine samples. Nontechnicians can operate the detector maintenance, calibration, and data interpretation are simple procedures. The detector is portable and can provide on-the-spot analysis. Its cost is estimated to be about five hundred dollars. Analysis will cost about one dollar per sample. Prototypes will be available in 1972 for testing by the cities and for consideration by industry.

Urine Analysis for Bacteria. A device was developed for the detection of life on other planets. Goddard Space Flight Center is adapting this device for use as a bacteria detector and counter. Trials at Johns Hopkins University Hospital Clinic Laboratories show this device to be hundreds of times faster and far more accurate than the standard culture techniques for finding and quantifying the presence of microorganisms, especially in urine.

Sewage Flow Meter. A low velocity measuring instrument, using fluidic techniques, was developed for NASA as an airspeed sensor for V/STOL aircraft. This device is being modified to monitor sewage flow under a project coordinated by the NASA Technology Applications



Team at Illinois Institute of Technology Research Institute. No moving parts are submerged in the flow. The sensor is rugged, self-cleaning, and does not obstruct the flow. Dallas Water Utilities will be testing a prototype meter currently under development.

Smoke Detector. A device was developed by NASA to detect contaminants in space cabin atmospheres. This technology will be applied to develop a small, low-cost reliable smoke detector. The Technology Applications Team at Abt Associates, Inc., is coordinating this project. A solid-state device will be coated with a polymer which selectively absorbs gases. The electrical properties of the device change as selected gases are absorbed. At set thresholds, these gases can trip an alarm. The cost of the sensor at production volume is estimated to be less than ten dollars.

Program Objectives and Conclusions

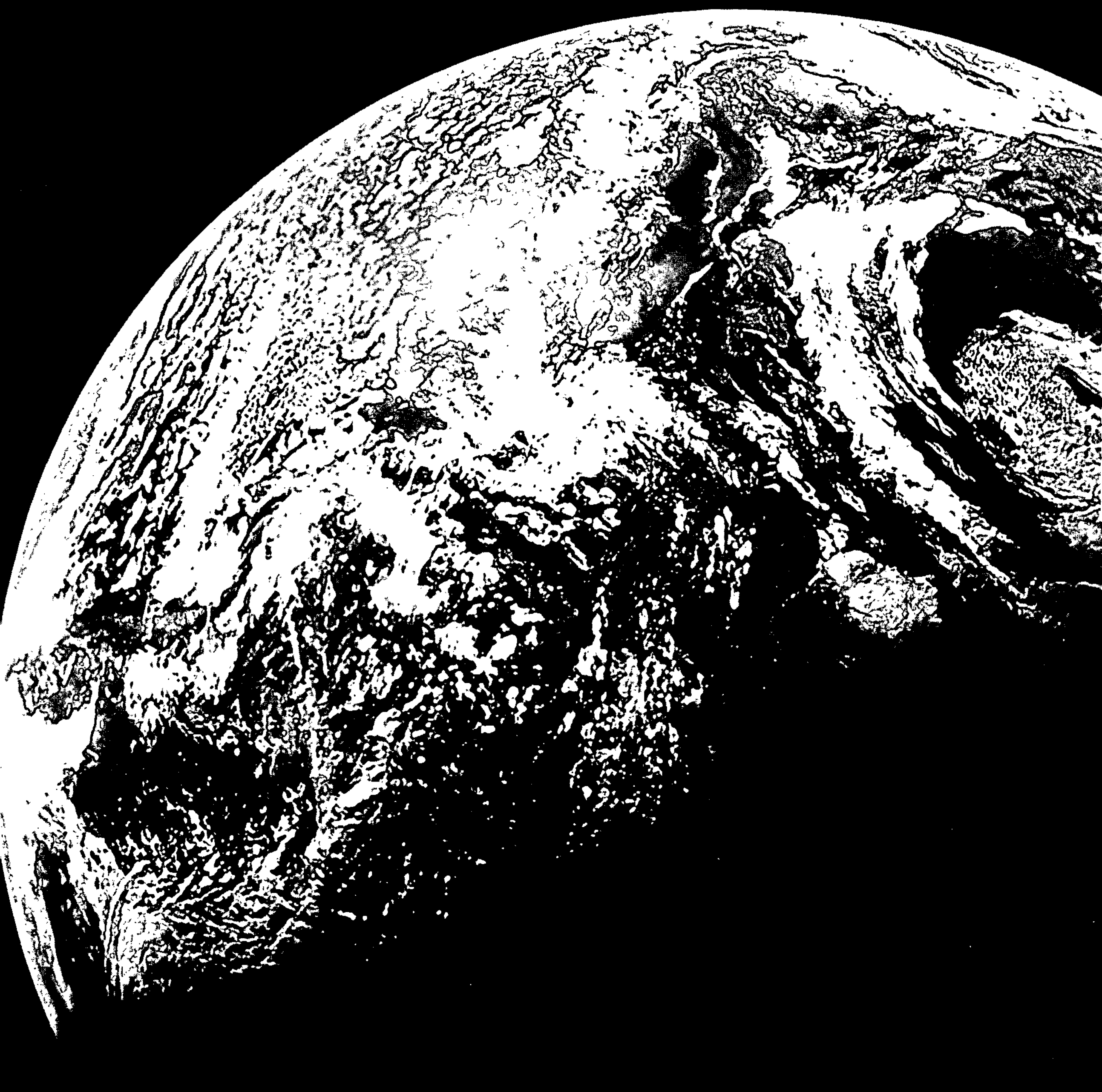
The initial objectives of the program to determine the feasibility of applying aerospace technologies and capabilities to municipal needs have been accomplished. Mechanisms have been established to allow city participation in all phases of the program and assure their full cooperation. Procedures have been developed from problem identification and selection to new product design, development, testing, and demonstration. Mechanisms for identifying problems common to numerous cities have been developed so that standard specifications can be arrived at, and existing technologies can be applied to the cities' needs.

The first year of activities in this program has demonstrated that urban needs can be matched with technical resources. The second year will concentrate on developing mechanisms for implementing solutions. During this period the program will focus on the development of new product development, testing and delivery. It will explore mechanisms for aggregating the urban market through vehicles such as centralized purchasing arrangements based on standard specifications. The topic of urban market aggregation will be explored by participating municipalities.

This program will also develop a more effective mechanism for information exchange with the participating cities through a bi-monthly newsletter. An attached reader information card will allow cities to rapidly respond to questions and to request additional information on selected items.

Through such mechanisms, Public Technology will attempt to pull together the fragmented urban marketplace to stimulate the introduction of new products developed by the application of aerospace technologies and capabilities, thereby improving the quality and productivity of urban services.

APPENDICES



APPENDIX I
PARTICIPATING JURISDICTIONS

Eighty Jurisdictions:
Total Population: 26,794,000

ALABAMA	
Anniston	34,000
ALASKA	
Anchorage	49,000
ARIZONA	
Phoenix	582,000
Scottsdale	44,000
CALIFORNIA	
Anaheim	146,000
Berkeley	116,000
Burbank	97,000
Carson	50,000
Chula Vista	51,000
Costa Mesa	66,000
El Monte	43,500
Fresno	156,000
Fullerton	76,000
Garden Grove	116,000
Inglewood	86,000
Long Beach	368,000
Los Angeles	2,695,000
Mountain View	48,000
Oakland	378,000
Orange	67,000
Pasadena	124,000
Riverside	131,000
San Diego	636,000
San Francisco	745,000
San Jose	308,000
San Leandro	72,000
Santa Maria	34,000
Stockton	93,000
Sunnyvale	83,000
COLORADO	
Boulder	50,000
Englewood	36,000
Pueblo	98,000
DISTRICT OF COLUMBIA	
Washington	810,000
FLORIDA	
Dade County	1,135,000
Fort Lauderdale	114,000
Hollywood	70,000
Pensacola	61,000
St. Petersburg	*200,000*
GEORGIA	
Atlanta	535,000
Savannah	141,000
ILLINOIS	
Champaign	53,000
Joliet	75,000
IOWA	
Des Moines	216,000
Dubuque	60,000
KANSAS	
Lawrence	39,000
Wichita	275,000
LOUISIANA	
New Orleans	655,000
MAINE	
Bangor	39,000
MASSACHUSETTS	
Boston	670,000
MICHIGAN	
East Lansing	36,000
Kalamazoo	86,000
MINNESOTA	
Richfield	49,000
MISSOURI	
Independence	107,000
Kansas City	530,000
NEVADA	
Las Vegas	110,000
NEW JERSEY	
Sparta	11,000
Woodbridge	*91,000*
NEW MEXICO	
Albuquerque	242,000
NEW YORK	
New York City	7,868,000
NORTH CAROLINA	
Charlotte	230,000
Winston-Salem	139,000
OHIO	
Cincinnati	495,000
Dayton	260,000
Toledo	393,000
Zanesville	38,000
OKLAHOMA	
Oklahoma City	380,000
OREGON	
Salem	64,000
SOUTH CAROLINA	
Spartanburg	47,000
TEXAS	
Dallas	790,000
Fort Worth	360,000
Grand Prairie	41,500
Wichita Falls	116,000
VIRGINIA	
Alexandria	115,000
Danville	48,000
Hampton	110,000
Newport News	130,000
Richmond	223,000
WEST VIRGINIA	
Wheeling	50,000
WISCONSIN	
Milwaukee	765,000
WYOMING	
Casper	43,000

APPENDIX II
NATIONAL COORDINATING COMMITTEE

Keith Murdoch (Chairman)
City Manager
Anaheim, California

Russell L. Brenner
Research and Budget Officer
Wichita, Kansas

Robert Cantine
Senior Management Analyst
District of Columbia Government
Washington, D.C.

Bruce Clark
Assistant City Manager
Pueblo, Colorado

Robert D. Johnston
Assistant to City Manager
Ft. Lauderdale, Florida

Vincent F. O'Donnell
Program Analyst
Boston, Massachusetts

Samuel H. Owen, Jr.
Director of Management & Engineering Services
Winston-Salem, North Carolina

Dean H. Vanderbilt
Urban Scientist
Dallas, Texas

APPENDIX III· TOP PRIORITY URBAN PROBLEMS

Problem Area:	Needs Specified:
PUBLIC SAFETY-GENERAL	
Command Control Systems	An improved communication system for emergency conditions, capable of transmitting audio-visual signals from the field to a command center, then relaying audio signals back to the field.
Emergency Telephone Communications	An emergency telephone call tracer and processor system capable of identifying a given phone number immediately; tracing the origin of a call within sufficient time to verify the location of emergency; (potentially ten seconds after initial phonecall); and feeding information thereafter into a computerized dispatch system, then providing print-outs to appropriate locations.
Emergency Vehicle Warning System	A sound mechanism capable of penetrating through vehicles, possibly coupled with a device to blank out car radios and also with a device to control traffic lights.
FIRE PROTECTION	
Self-Contained Breathing Apparatus	A means of furnishing firemen, working in hazardous smoke and toxic-fume environments, with a life-support breathing apparatus; past systems have been either too heavy, bulky, too difficult to don and doff, and/or too limited in air-supply duration.
Short-Range Communication Systems for Firemen	Better equipment for communication purposes enabling firemen to send and receive messages while on the fire scene; (both with one another inside, and the officer in command outside, the burning structure); integrated with the normal fireman's gear; and devoid of interference during transmission.

Problem Area:	Needs Specified:
FIRE PROTECTION *(continued)*	
Protective Clothing For Firemen	Clothing that is heat-reflective, flame-resistant, water-repellent, light, durable, and easy to put on; those currently available fail to meet the above standards of safey.
Automatic Fire Hose Flow Regulator	A control device for regulating water flow at the nozzle; monitoring other engine functions simultaneously so that multiple functions could be operated remotely at the scene of the fire. Present systems require stationary pump operators limiting his assistance to other operations.
New Fire Hoses and Couplings	Fire Hoses of lighter weight, longer durability, heat-resistant, compactable, and non-kinking; couplings capable of quicker fastening. At present, no standards of uniformity for size and thread of couplers exist, resulting in adjacent communities having entirely incompatible equipment.
Hazardous Environment Alarm for Firemen	A simple metering device compatible with the fire-fighter's gear, capable of detecting and triggering an alarm in any of the following atmospheres: oxygen-deficient, toxic, explosive, and radiation.
Hot Spot Locator	A means of locating the origin of a fire or heart of a fire within a building; capable of locating also the origin of a fire within the individual walls of a building.
Fireproofing of Home And Office Furnishings	Low-cost, easy-to-apply material, which will render household and/or office furnishings fire-resistant, and of low, non-toxic smoke potential.
Fire Proof Building Materials	New and improved building materials which are heat-resistant and flame retardent, and also non-toxic when subjected to heat.
Alternate Fire Extinguishing Methods	Present and primary system is the standard water pumper. Two new approaches are being tested to (1) effectively utilize water, (Rapid Water), and (2) use various chemicals and compounds such as foams to better utilize valuable water supplies.

Problem Area:	Needs Specified:
LAW ENFORCEMENT	
Body Armor	Better protective clothing for policemen against high-velocity projectiles, rocks, and other debris. Three different situations require three solutions: (1) protection against high-powered firearms. (2) protection during riots from small firearms and manual weapons. (3) and protection during normal conditions such as routine patrols.
Communications Systems For Policemen	Lighter-weight, more compactible transceivers for individual foot patrolmen; device capable of incorporating a locator as well.
Night Vision	Device for surveillance and detection; present systems require two different mechanisms for both functions; (the light-intensification and thermal-imaging respectively.)
Non-Lethal Weapons	Capable of immobilizing suspects without fatal damage or mutilization for policemen; also capable of firing from a distance of 100 feet minimum.
Locator Systems For Police Patrols	System to track either a vehicle or another policeman, capable of computing location coordinates for automatic reporting to a central dispatch system.
Suspect Identification: Fingerprint Transmission	Improved means capable of remote suspect identification as in roadblocks and stake-outs; capable of improved transmission reception as in fingerprint identification from local headquarters to central computer banks; improved weather-conditioned monitors for insured quality of transmission.
Miniature Portable Video Communication	Improved, portable TV *cameras for command control centers, suspect identification,* high-crime area surveillance, emergency patient status-assessment, and traffic surveillance; improvements require better transmission to and from remote areas, less weight, lower-cost and reductions in size.

Problem Area:	Needs Specified:
HEALTH AND RESCUE SERVICES	
Emergency Patient Monitoring	A means to remotely monitor the vital signs of a patient. Application of NASA's developments, in devices and telemetry for monitoring the astronauts' conditions, to patients being transported to medical facilities could be invaluable. It would also be needed for patients in remote areas who are unable to reach a hospital or specialist.
Non-Emergency Patient Monitoring	Capable of conducting routine examinations more effectively and efficiently as well as economically; NASA has developed non-invasive techniques for monitoring functions which do not require implanting sensors or electrodes.
SOLID WASTE MANAGEMENT	
Toxic and Flammable Waste Disposal	A means of safely disposing of toxic and flammable wastes—burial could cause contamination of ground water; dumping into sewers might yield water pollution; identification and neutralization of the waste products is required.
Remote Processing Of Solid Waste	Method for the maximum volume reduction of municipal wastes (solids) at the optimum point in the collection system.
Solid Waste Management Techniques	Improvements in solid waste management techniques such as work performance and productivity of collection crews, a computerized optimization of collection routes, etc.
Methane Detector For Landfills	Device to measure the level of methane concentration, to allow for safe re-use of sanitary landfills.
Junk Car Disposal	A means of economical, non-polluting disposal and resource developments for the improved waste of ferrous and non-ferrous metals.

Problem Area:	Needs Specified:
SEWAGE TREATMENT DISPOSAL	
Decentralized Sewage Disposal System	Means of disposing of or limiting the effluence of liquid and solid wastes as near the point of origin as practical, thereby reducing demands of collection crews.
Centralized Sewage Disposal System	Methods for rapid treatment of sewage; improved drying or de-watering of wastes; of higher effectiveness, less cost, and capable of handling increased work loads.
Automated Sewaging and Control Devices	Devices for the sensing, measurement, and control of influent and effluent products; accurate parameters must be determined to effectively manage a sewage facility (sewage volume and flow); means of detecting in-flow chemicals so to protect bacteria used to decompose wastes; systems to determine toxicity of liquid waste, including improved biochemical oxygen demand (BOD); to test and monitor sewage emissions.
WATER POLLUTION	
Portable Lab for Bio-Assays And Particulate Matter	A portable device to measure impurities in water used for recreation and drinking purposes.
Economic Reclamation Method For Low-Saline Water	Method for reclamation of low-saline water for drinking purposes, open wells, municipal water facilities; most affected area is the Northern regions of the country where salt is used to de-ice highways but contaminates underground waters.

Problem Area:	Needs Specified:
TRAFFIC SAFETY AND CONTROL	
Pavement Marking	Materials for marking better traffic lines on streets; improved durability, reflectivity especially when wet.
Traffic Control Systems	A more efficient and inexpensive means of interconnecting traffic sections and signals for optimum coordinated operation; present means of cables or leased telephone lines are expensive.
Portable Traffic Counters	A portable traffic counter, protected against abuse by vandals and pranksters, which can distinguish between lanes, direction, and rate of traffic, (as many permanent counters can).
Street Patching	A truly permanent patching material is required which can be easily and rapidly applied over a wide range of temperatures and which would be able to withstand severe thermal and dynamic stresses and corrosive materials.
Street and Sidewalk De-Icer	A non-polluting, non-corrosive, low cost material or method for the removal or prevention of ice formation on public highways. Commonly used salt causes corrosion and pollution of ground water.
Traffic Sign Materials	Improved light-weight material for large overhead traffic signs; present usage of breakaway signs accentuates the need for light-weight and strong sign material; should also have good reflective qualities in both rain and frost conditions.

Problem Area:	Needs Specified:
UTILITIES	
Underground Utility Locator	A simple, easy to use, reliable method for locating and identifying underground pipes, conduits, and cables; present metal detectors and minesweep techniques are not sensitive to all types of utility lines, particularly sewer and plastic pipes.
Electrical Fault Detection	A portable device to locate faults in underground and overhead power lines, to increase reliability and continuity of electrical services.
High Voltage Power Transmission	A lower cost and more efficient means of underground high power electric transmission.
Remote Meter Reader	An economically feasible method of reading utility meters automatically and remotely.
Unit or Auxiliary Power Resources	An improved unit or auxiliary power source for emergency power operation; existing generators appear to be limited by size and/or inadequate power, and questionable reliability due to infrequent use.

APPENDIX IV

PROBLEM PRIORITIES BY REGION

	Western	Eastern	Midwest
Total Number of Cities in Region	29	14	16
Number of Cities Attending Regional Meetings	22	58.3%	61.5%
Percent of Cities Participating in Meetings	75.8%	24	26

Statements	Total Votes	Western Number	Western Rank	Eastern Number	Eastern Rank	Midwest Number	Midwest Rank
Firemen's Life Support System	38	15	2, 3	13	2	10	2, 3, 4, 5
Pavement Striping	36	17	1	9	3, 4, 5	10	2, 3, 4, 5
Underground Pipe and Conduit Locator	35	14	4	7	6	14	1
Communication Equipment for Firemen	35	11	7, 8	14	1	10	2, 3, 4, 5
Firemen's Protective Clothing	32	13	5	9	3, 4, 5	10	2, 3, 4, 5
Protective Body Armor—Police Use	28	15	2, 3	9	3, 4, 5	4	11
Automatic Fire Hose Pressure Regulators	22	12	6	4	8, 9	6	7, 8
Disposal of Toxic and Flammable Materials	20	9	9	4	8, 9	7	6

Statements	Total Votes	Number	Rank	Number	Rank	Number	Rank
Command/Control Center Design	20	11	7, 8	3	10	6	7, 8
Electronic Traffic Counter	13	6	10	2	11	5	9, 10
New Hose and Hose-Couplings for Fire-Fighting Use	10	4	11	1	12, 13, 14	5	9, 10
Patient Monitoring: Emergency	9	1	14, 15	6	7	2	14
Electrical Fault Detection	6	2	12, 13	1	12, 13, 14	3	12, 13
High Voltage Power Transmission	5	2	12, 13	0	15	3	12, 13
Patient Monitoring: Non-Emergency	3	1	14, 15	1	12, 13, 14	1	15

Note: 52 Cities Participated—66% of Total Cities (80)

APPENDIX V

USER DESIGN COMMITTEES

**Breathing Apparatus
User Design Committee**

David B. Gratz
Chief of Fire Department
Silver Spring, Maryland

James E. Kehoe
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**Underground Pipe Locator
User Design Committee**

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APPENDIX VI

TECHNOLOGY APPLICATION METHODOLOGY

This section concerns the requirements for systematically applying science and technology for the improvement of our urban services. It outlines functions that generally need to be performed in the development, utilization and delivery of technology to the cities.

Two basic strategies may be used in any problem-solving activity. One may begin with problems in search of solutions or one may begin with solutions in search of problems. In practice, a mixed strategy is often used. Adequate solutions to urban problems generally will require a wide variety of technical resources and capabilities. On the other hand, some technologies will find broad applications. To solve only immediate problems with a given technology would constitute an inefficient use of resources. The order in which the various functions are presented is not meant to express a preferred strategy but rather to provide a conceptual structure in which to discuss their interrelationships.

Problem Identification and Analysis. One of the most critical functions in an urban environment is the identification of important problems that have a significant technological component. If the systematic application of science and technology is to have significant impact on our cities, problems that have a major technological component, problems where technology can make a difference must be identified. Complex urban problems have many dimensions, none of which can be ignored. However, some problems require more technical input than others and these are the ones we should seek.

Problems must be identified at the appropriate level of detail. They must be specific enough to enable a technologist to relate alternative technologies to it, but not so specific that a certain technological approach is either presupposed or excluded. When problems that are too general to relate to specific technologies are identified, they may often require decomposition into sub-problems before alternative technological approaches can be effectively considered. For example, cities have a need for better methods of disposing of hazardous waste. Because of the variety of types of hazardous waste, there seems to be no black box solution which will accept any and all toxic materials at one end and produce non-toxic materials at the other. The problem has to be broken down into sub-problems such as the disposal of heavy metals, the disposal of pesticides, the disposal of oil, and the disposal of radioactive materials.

Urban Requirements Survey. Once a need that is of general interest to cities has been identified, it is important to get an accurate reading on how important and universal the problem is. A problem statement will list the constraints and specifications for an adequate solution. To what extent do other cities agree with these as they are stated? Is there a consensus? If not, can the differences be correlated with city characteristics such as size or climate? Which constraints are most important?

In addition, it is important to know the systems, equipment, or materials a city currently is using or has tried, the requirements it has failed to meet, and why. This pinpoints where users feel improvements in existing equipment need to be made. In some cases, the survey will reveal that a city may have satisfactorily solved the problem and has a viable solution that can be used by other cities as well.

It is also important to determine the size of the replacement market for improved equipment, the growth rate of that market, and whether new markets might be created for improved equipment. For example, the market for a self-contained breathing apparatus for firemen will be expanding very rapidly over the next several years, primarily because the National Fire Protection Association recently declared the popular filter-canister mask for fire fighting unsafe and passed a standard prohibiting its use.

Product Survey and Evaluation. The urban requirements survey determines where gaps are thought to exist from the city point of view between the problem requirements and existing product or systems performance. It is important to take an independent look at commercially available products or systems currently servicing the need. For example, it may be that poor performance may not be due to inadequate equipment but rather to improper use. This was, for instance, the response we received from the manufacturers of metal pipe locators. They claimed that their equipment could detect underground metallic pipe as deep as twenty feet. Some public works officials claimed that they have never detected a pipe below twenty inches with their equipment. The manufacturers claim that the operations were improper; the operators claim that the equipment is inadequate.

Such disputes can be resolved by designing and conducting tests to evaluate product performance. As standard specifications are drawn up for urban products, new and existing products need to be tested to determine whether they meet the standards. Once product performance is adequately evaluated and compared with the problem requirements, the opportunities and needs for improvement can be determined precisely.

The product survey and evaluation also serves another function. Occasionally a product will be found which adequately solves the problem but is not being marketed to the city. In this case, a new market is discovered for this product.

Technology Survey. Once the need has been precisely identified and confirmed, promising alternative approaches to the problem need to be determined. For example, even if commercially available metal pipe locators work satisfactorily, other kinds of pipes such as plastic, concrete or clay need to be located underground. Plausible alternative methods for locating underground metallic and non-metallic pipes might include wide-band UHF radiometry, downward looking radar, and sonar. The state-of-the-art of each of these technologies must be surveyed to determine whether it is advanced enough to be applicable to the problem now or whether it requires further development.

Once alternative technological approaches have been identified, in-depth technical literature searches should be conducted. In addition to identifying relevant technologies, technical information searches serve two important functions. They help the technical generalists of the applications team to become conversant in a specific area, and they provide a means for identifying the experts in the field. The quickest way to get an accurate reading on the state-of-the-art in a specific discipline is to talk to the experts. They are also in the best position to evaluate the relevance of the technology to the problem.

Problem Selection and Evaluation. At this point, specific urban requirements have been surveyed for degree of agreement. Commercially available products have been surveyed and evaluated, and finally, available technologies that are potentially more relevant to solving the problem than existing equipment have been surveyed and identified.

With this information, questions about each problem can be answered: can urban requirements be met with commercially available equipment about which cities were unaware; can urban requirements be met with available technologies not previously applied to the problem; which problems require the further development of new technologies?

A problem selection policy will have to be established to guide the trade-offs between various criteria for problem selection. For example, we may want to require that a research and development agenda have a mix of immediate and long-range benefits. Early results in a program of this type are essential. However, it is also important not to ignore problems which can have greater benefit to cities in the longer term. For the two categories of problems that require applications engineering or further research and development, decisions should be made on the basis of the costs to implement a solution and the benefits to be accrued from a better solution, subject to the type and amount of risk one is willing to bear in terms of the probability of success of the project.

Technical Feasibility. Based on information gathered so far, and on a decision to modify existing technology or develop new technologies to solve problems, the various alternative technological approaches need to be analyzed in greater depth. The exact technical parameters required for improvement must be examined and the probability of new technologies making improvements in these parameters must be evaluated. For example, in the development of fire-retardant coatings and paints, the critical technical parameter controlling quality turns out to be the amount of pigment per unit of volume. If it can be shown that NASA fire-retardant paint formulations significantly increased the amount of pigment per unit of volume over commercial fire-retardant paints, then technical improvement is not only feasible but accomplished.

Urban Market Feasibility. Even if a solution to the problem is technically feasible, it may not be feasible in the urban market place. An urban market feasibility study should estimate the development and production costs, and product price. It should estimate the total market size (replacement plus new markets) and the market share that the manufacturer could expect to capture. It should analyze the nature of the relevant sector of industry and the nature of competitive products. It should look at product acceptability from the users point of view, and at purchasing and political constraints. Finally, it should look at the potential for market aggregation in terms of common specifications for a large number of cities, potential commitment on the part of the cities, and the potential for aggregated purchasing agreements. All of these factors will go into determining whether a potential product of the type under consideration will have a competitive chance in the urban market place. This function is extremely important since it provides an indication of whether or not the technology will ever get out of the laboratory. A large majority of the new products developed never reach the market place. An urban market feasibility study provides a critical input to the decision to commit applications engineering or development funds.

Technology Assessment. Before making the final selection of applications engineering or development projects, the political, social, economic, and ecological impacts of each project should be explored. For example, some proposed solutions may have significant effects on an industry, such as the impact industrialized housing may have on the building industry. Other proposed solutions may have undesirable environmental effects, and therefore, serious political ramifications. These possible effects need to be anticipated before large expenditures of capital are poured into development.

Project Selection. If the solution under consideration appears to be technically feasible, feasible in the urban market place, and the negative impacts of the technological change do not outweigh the positive, then it becomes candidate for funding. Not all prospective projects will be funded since resources are limited. Only those projects most likely to succeed and/or which yield the greatest benefits to the cities should be selected. Resource allocation procedures take into account budget, manpower, and time constraints in addition to the cost, benefit, and success probabilities discussed previously.

User Commitment. Commitments to try or test the new product need to be obtained as early as possible in the life of a project. Urban market feasibility studies will not always give an accurate appraisal of the extent to which users are willing to commit themselves. The firmer the commitment one can obtain, the better. A commitment to purchase a set number of units is most desirable but cannot always be obtained.

User commitment is an effective incentive for industry to become involved in conducting and funding research and development and applications engineering. The two basic incentives for industry in this program are Public Technology's ability to aggregate the market by writing standard specifications and developing joint purchasing agreements, and its ability to obtain some degree of commitment from specific cities.

Project Funding. There is a variety of sources of funding for selected projects. Projects may be funded by contract or grant, out of specific mission-agency programs of the federal government such as the National Aeronautics and Space Administration, Department of Transportation, National Science Foundation, Law Enforcement Assistance Administration and Department of Housing and Urban Development. They may be funded by a firm interested in developing new products for the cities. They may be funded by foundations interested in seeing technology applied to urban problems. It is expected that selected cities may want to pool their resources and provide support for specific new product developments. In any case, funding for the selected projects must be secured. Since federal dollars are becoming increasingly scarce, industry should be encouraged as much as possible to support research, development, and applications engineering projects.

Research and Development/ Applications Engineering. In cases where available technologies can be applied to meet the urban requirements, modification of existing technologies may be required in the new application. We refer to this type of modification as applications engineering.

A project requiring applications engineering will be initiated by drawing up a set of engineering specifications for a prototype and a project plan. The specifications will indicate tasks to be completed and the timing and resources required for each task. This will be done either by the organization conducting the applications engineering or the agency letting a contract for this work.

Obviously, the next step is to actually carry out the applications engineering. During the course of the project, technical decisions that will significantly affect the end product will be required. Experts who understand the user point of view should be involved in each of these decisions so that the urban requirements can be kept clearly in focus and interpreted not by high technology engineers, but by those closest to the problem.

Where the development of new technologies is required to meet the urban requirements, a prior step is required. A research and development plan must be developed which will lead, if successful, to a set of engineering specifications and prototype development. In either case, the end result will be a prototype.

Prototype Testing and Evaluation. In addition to preliminary laboratory testing of the prototype to see if it meets the engineering specifications, two other types of testing and evaluation procedures are required. First, standards and codes for equipment of a certain type often are specified. Generally, organizations have been established for approval of new products of a particular type. The prototype must be tested and evaluated by the appropriate organization for approval. The project managers and engineers should be cognizant of the relevant codes and standards from the beginning, the approval organization should be consulted in the early stages of the project, kept abreast of progress and be made aware of any changes in direction.

In cases where there are no standards, and where no organization for establishing standards exist, the product should be evaluated for safety and maintenance characteristics. Where possible, preliminary standards should be established.

The prototype also should be tested and evaluated for its performance under the intended application, even if only under simulated conditions. These tests should be conducted under realistic conditions to determine whether the product's performance lives up to expectations. To the extent possible, it should be tested by those who ultimately will use the product.

Patent and License Arrangements. Patent and license agreements need to be arranged, as required, to facilitate the delivery of technology to the cities.

Conduct Pilot Demonstrations. Prototype products should be put into operation on a small scale before the manufacturer tools up for full production and marketing. This kind of field testing in selected sites can determine how well the product meets urban requirements. The sites for pilot demonstrations should be carefully chosen so that the product can be evaluated under a range of conditions such as small city fire department operations versus large city fire department operations; cold, wet climates versus hot, dry climates, and so forth.

Pilot demonstrations serve two important functions. They allow the manufacturer to alter the product to meet difficulties which may be revealed in operation. They provide a mechanism for building credibility for the new product in the cities. Other cities will be watching these demonstration projects carefully and critically.

Site selection also should take into account leadership of cities. Certain cities are regarded as leaders in certain urban service sectors.

Business Study. Even if the pilot demonstrations are highly successful and interest from the cities is running high, the manufacturer will want to conduct thorough market studies to determine the sensitivity of price to production volume and to market share; the product's ability to compete in the market place, the break-even point in sales, and the product's life expectancy. The fact that a product sells does not insure a profitable operation. A business study relates market characteristics of the product to sales and profits of the operations.

Product Manufacturing and Distribution. At this point, if a product offers profit potential, a company will tool up for full-scale production. In many cases, the companies that have the capabilities to manufacture new products that incorporate sophisticated technologies may have to use distribution channels with which they are unfamiliar. This may be a serious barrier to a firm when deciding whether to enter the urban market. New and innovative distribution patterns may be required to attract industry to the urban market place.

Diffusion to Other Cities. Assuming that distribution capabilities can be acquired, information about the new product and the experience of the pilot cities with the new products must be disseminated widely. This can be done through the standard advertising channels and through demonstrations at trade and professional association meetings and other associations, such as states leagues of municipalities. This information also will be disseminated directly to cities through the Science and Technology Clearinghouse being developed by Public Technology.