REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

Technology Transfer And Innovation Can Help Cities Identify Problems And Solutions

National Science Foundation

National Aeronautics and Space Administration

Bringing technology into cities is a complex, long-term process because social, political, and/or economic factors are often barriers to technological solutions to public problems.

The California Four Cities Program was an experiment to find out if aerospace technology could be used to help solve cities' problems.

The program generally met its stated objectives. The participating cities and industries each benefited, but the benefits are difficult to measure.

Some lessons learned may be useful in conducting similar future programs.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

The Nation's cities are faced with numerous problems relating to issues such as law enforcement, fire prevention, environmental pollution, and public transportation. The Federal Government has undertaken several programs to determine whether technology would help alleviate the problems. One such program was the California Four Cities Program which was cosponsored by the National Science Foundation and the National Aeronautics and Space Administration in Anaheim, Fresno, Pasadena, and San Jose. This report summarizes the results of our study of the program.

A primary program objective was to determine whether technology developed by the aerospace industry could help the participating cities. To that end, senior aerospace professionals were assigned as advisers on the city managers' staff. The aerospace advisers were assisted by their respective companies which provided technical support at no charge to the cities.

Our study was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget; the Director, National Science Foundation; and the Administrator, National Aeronautics and Space Administration.

Comptroller General
of the United States

Contents

ABBREVIATIONS

GAO	General Accounting Office
JPL	Jet Propulsion Laboratory
NASA	National Aeronautics and Space Administration
NSF	National Science Foundation

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

TECHNOLOGY TRANSFER AND INNOVATION CAN HELP CITIES IDENTIFY PROBLEMS AND SOLUTIONS
National Science Foundation
National Aeronautics and Space Administration

D I G E S T

The California Four Cities Program--cosponsored by the National Science Foundation and the National Aeronautics and Space Administration in Anaheim, Fresno, Pasadena, and San Jose--was an experiment to find out if aerospace technology could be used to help solve municipal problems.

In addition to the Four Cities Program, the Federal Government is sponsoring other experimental programs to try to apply technology to local government problems, such as the Department of Housing and Urban Development's Urban Observatory Program. Similar programs will continue to be implemented. The Solar Heating and Cooling Demonstration Act of 1974 (42 U.S.C. 5501), for example, provides for a joint agency program for developing and demonstrating solar heating systems for use in residential dwellings.

The Congress should use this report in reviewing and evaluating ongoing and proposed experimental programs to apply science and technology to help solve State and local government problems.

GAO found that:

--The Four Cities Program generally achieved its stated objectives. (See ch. 3.)

--Aerospace professionals working closely with city officials can help the cities identify problems and develop technological solutions. (See pp. 13 and 14.)

--The cities benefited in many ways, but mainly through changes in management attitudes and styles and by gaining problem-solving expertise. Benefits, however, were not always measurable. (See pp. 15 and 16.)

--Industries gained insight into municipal government operations but did not realize any immediate expansion of business. (See pp. 16 and 17.)

--Bringing technology to cities is a complex long-term process because social, political, and/or economic factors often are barriers to technological solutions to public problems. (See p. 19.)

--Industry is reluctant to invest considerable time and money in trying to research and solve city problems when potential commercial markets are unknown. Cities regard research as risky and are hesitant to invest their funds. (See pp. 19 to 21.)

--Although transferring any technology from industry to cities is difficult to achieve, on the basis of this program it appears that hardware or equipment is usually more difficult to transfer to cities than software, such as a management improvement system. (See pp. 21 and 22.)

--One of the most important aspects of transferring technology to cities is developing mutual trust and confidence between city officials and technology advisers. (See pp. 22 and 23.)

--The National Science Foundation and National Aeronautics and Space Administration did not always agree on how the program was to be managed, especially regarding the extent to which results were to be publicized for use by other cities. (See pp. 24 and 25.)

--The National Science Foundation is sponsoring an extension of the Four Cities Program in addition to a number of other projects designed to bring technology into local governments. (See pp. 17 and 18.)

GAO recommends that the Director of the National Science Foundation:

--Emphasize the need to measure participants' attitudinal changes, such as increased

receptivity to technology, in future programs to apply science and technology to urban problems.

--Require, to the extent practicable, that criteria for selecting projects to be undertaken during such programs include the possibility of making cost/benefit measurements.

--Require that the programplanning phase of multiagency programs include a definition of the specific responsibilities of each program participant. These responsibilities should be detailed in the documents governing the program's operation.

The National Science Foundation agreed to adopt the recommendations. (See pp. 28 and 29.)

CHAPTER 1

INTRODUCTION

There has been a growing concern over the quality and efficiency of services delivered by all levels of government, but particularly of State and local levels because their services are the most visible. The public has begun to express dissatisfaction with municipal services usually taken for granted (for example, law enforcement, fire protection, education, housing, environmental protection, public transportation, and water quality). Because the Nation had been successful in applying technology in the private sector and to some of our national problems, both the local and Federal levels of government have begun looking to technology for aid in solving these local public problems.

At the local level, numerous studies have been made by public interest groups and many conferences have been held to identify ways of applying technology to the local governments' problems. At the Federal level, using the Agricultural Extension Service as a model, the Government began trying methods during the 1960s for getting research and development results to the cities through such efforts as the State Technical Services Act of 1965 (15 U.S.C. 1351), the Department of Housing and Urban Development's Urban Observatory Program, and the programs of the National Aeronautics and Space Administration's (NASA's) Technology Applications Office. In addition, the National Science Foundation (NSF) has sponsored a number of experimental programs designed to use science and technology in the cities. One of those programs, sponsored jointly with NASA, was the California Four Cities Program--an experiment with partnerships involving the Federal Government, local governments, and aerospace industry. (See app. IV for brief descriptions of other NSF efforts.)

What would be the value of an aerospace professional in the city? Could he contribute? Would communication problems prove to be a barrier to understanding? Could the aerospace industry find a new market in the cities for its technology and expertise? The Four Cities Program was designed to answer these and other questions.

In an earlier report entitled "Means For Increasing The Use Of Defense Technology For Urgent Public Problems" (B-175132, Dec. 29, 1972) we pointed out opportunities for more effectively transferring Department of Defense technology to other Federal agencies. In contrast, our study of the Four Cities Program was concerned primarily with the problems in transferring aerospace technology to local governments. We tried to determine how well the program achieved its objectives and to identify lessons learned during the program which could be applied to future programs using technology for solving domestic problems.

Although the Four Cities Program experiment is not expected to demonstrate how best to bring technology into the cities, it can contribute to understanding the change and innovation process in the public sector, the barriers and constraints limiting innovation, and the fundamental concepts of successful technological innovation.

According to many authorities, to make Federal technology effective in dealing with public sector problems, the State and local governments must be technically capable of dealing with science and technology.

The Intergovernmental Personnel Act of 1970 (42 U.S.C. 4701 nt.), which provides for an interchange of Federal, State, and local personnel, is an example of a technical assistance program designed to improve the manpower quality at all governmental levels.

The magnitude of the resources involved in Federal-State-local partnerships is illustrated by the following:

--Federal assistance is available through programs conducted by the 50 States, about 3,000 counties, and nearly 90,000 local governmental units.

--The Federal assistance programs, sponsored by about 20 executive branch departments and agencies, number from approximately 500 to 1,300, depending upon program definition.

--Federal assistance to State and local governments rose from about $3 billion in 1955 to an estimated $56 billion in 1976.

The President's policy statements on science and technology in 1972 and on Federalism in 1974 clearly indicate a desire to give State and local governments increased responsibility for conducting their affairs. (See app. I and II for pertinent portions of these statements.)

CHAPTER 2

DESCRIPTION OF THE FOUR CITIES PROGRAM

The Four Cities Program was an experiment in public sector technology innovation and transfer in which four aerospace industry professionals were placed in key advisory positions in the California cities of Anaheim, Fresno, Pasadena, and San Jose. The program's purpose was to evaluate the potential of applying aerospace technology to urban problems. The program was developed by NSF's Office of Intergovernmental Science and Research Utilization and the Jet Propulsion Laboratory's (JPL)[1] Space Technology Applications Office, which functioned under the support of NASA's Technology Applications Office as program designer, manager, and evaluator.

The Federal interest in testing the aerospace professionals' value in the cities stemmed from the nationally depressed market for aerospace scientists and engineers in the late 1960s. The Federal Government made efforts to aid distressed aerospace personnel. One such effort was the Department of Labor's Technology Mobilization and Reemployment Program. In addition, the Congress and the executive branch debated over how to better match the Nation's resources to its needs. Aerospace professional societies were also actively seeking employment for aerospace personnel through job-matching services.

Specific information on the contribution the aerospace industry could make to the cities seemed useful. Consequently, in February 1971, JPL submitted to NSF and NASA a proposal entitled "A Pilot Demonstration Project of Technology Application from the Aerospace Industry to City Management." An NSF/NASA interagency agreement was executed in June 1971 authorizing the Four Cities Program and establishing funding support.

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[1] JPL is a Government-owned laboratory operated by the California Institute of Technology under contract with NASA.

PROGRAM OBJECTIVES

The program was structured in accordance with the JPL proposal's general and specific objectives. The general program objectives were to:

> "Advance the understanding of public issues and problems having scientific and technological content at the State and local levels of government, and assess the needs and opportunities for more effective application of science and technology.
>
> "Demonstrate innovative science and technology planning and decisionmaking process related to State, local, and regional problems.
>
> "Stimulate selected State and local governments' experimentation, on a pilot basis, with science and technology systems in the context of their own needs and resources.
>
> "Encourage adoption of new systems which show promise for enhancing State and local ability to incorporate science and technology into public programs.
>
> "Improve communication between persons and groups concerned with science and technology at the Federal, State, and local levels of government."

The specific program objectives were to:

> "Determine the ability of industrial aerospace professionals to contribute directly in the environment of the cities at this level.
>
> "Determine the nature and amount of technical support required to implement a program to bring aerospace technology to local governments.
>
> "Expose city personnel to the 'systems approach' and thereby enhance their performance through this educational process.

"Expose aerospace personnel to the socio-political process in the cities to enhance their understanding of the cities' problems.

"Assess the applicability of aerospace technology and expertise to problems of the cities.

"Evaluate whether or not this type of arrangement is beneficial to the cities and to the aerospace industrial community."

Our assessment of the extent to which the specific objectives were achieved is contained in chapter 3.

PROGRAM PARTICIPANTS AND RESPONSIBILITIES

NASA and NSF provided the program's financial support in addition to overall advice and direction. The other program participants' responsibilities were as follows:

City--Provide free space and associated services and allocate staff and executive time to help the adviser define problems and implement technological solutions.

Industry--Provide, on a reimbursable basis, a qualified professional to serve as an adviser in permanent residence with the city and supply, annually at no cost, requested technical support equivalent to a maximum of 1 staff-year of effort.

Adviser--Under the city manager's direction, be responsible for advice in matters related to applying science and technology toward managing and operating the city.

JPL--As program manager, organize, direct, and coordinate the program participants' activities. This responsibility included: (1) selecting participating cities and industries and helping the cities select advisers, (2) procurement and contract administration activities, (3) organizing and coordinating quarterly program review meetings, (4) technical backup support to each adviser when needed, and (5) preparing monthly, annual, and final program evaluation reports.

Selection criteria

The participating cities were not selected on the basis of preestablished criteria. According to JPL officials, the main factors considered in the final selection were that the cities represented different urban situations and were receptive to introducing new concepts. Additional factors included the (1) prominent role in the International City Management Association-NASA Technology Application Program (Anaheim), (2) previous urban technology project participation with aerospace industry (Fresno), (3) proximity and association with JPL (Pasadena), and (4) preference by aerospace company (San Jose). A profile of the cities follows.

Anaheim--Major expanding community in suburban Orange County near Los Angeles with a population of 180,000 and growing. Anaheim is a residential community with a balanced economy of light industry and entertainment.

Fresno--Center of agricultural Fresno County with a population of 170,000 and growing. Though Fresno has sought a diversified economy, it remains an agricultural center with much of its commerce and manufacturing related directly to agricultural processing.

Pasadena--A suburban community in Los Angeles County with a population of 113,000. Pasadena is the smallest of the four cities and, with the addition of light industry, is undergoing changes from a residential, service, and tourist community to a more balanced economy.

San Jose--Located in Santa Clara County and with a population of 450,000 San Jose is the oldest, largest, and fastest growing of the four cities. It is a large industrial center with a diverse agriculture, transportation, manufacturing, and research-oriented economy.

The companies chosen for the program were selected on the basis of their (1) large-scale aerospace programs and systems management, (2) experience in civil systems programs, or (3) demonstrated interest in applying aerospace management techniques in governmental and institutional areas.

The city/company team pairings at program inception were: Anaheim and North American Rockwell Information Systems Company, Anaheim, California; Fresno and TRW Systems Group, Redondo Beach, California; Pasadena and Aerojet-General Corporation, Space General Company, El Monte, California; and San Jose and Lockheed Missiles and Space Company, Palo Alto Research Laboratory, Palo Alto, California. Rockwell withdrew from the program and was replaced by the Northrop Corporation (Electro-Mechanical Division), Anaheim, California. After a year with the program, TRW withdrew and was replaced on the Fresno team by La Jolla Research and Business Associates, a wholly owned subsidiary of Science Applications, Inc., La Jolla, California. The other city/company teams remained unchanged except for transferring Aerojet's technical support responsibilities to its Liquid Rocket Company, Sacramento, California.

Selecting advisers was a joint effort by the respective city managers and their staffs, the parent aerospace companies, and JPL. The general qualifications required of each candidate nominated by the parent companies were as follows:

--From 8 to 15 years' experience in the aerospace industry, preferably with the parent company.

--Project (or hardware) systems orientation and experience.

--Good communication and presentation skills.

--Strong personal motivation to assist in solving urban problems.

Each city manager made the final selection on the basis of his appraisal of the candidates' technical background, organizational ability, objectivity, seniority in industry, and ability to interrelate with people at all levels.

MAJOR PROJECTS UNDERTAKEN DURING PROGRAM

The city/company teams each selected at least one major project with the goal of improving existing local conditions, introducing new operations or capabilities, or enhancing city administration. A description of some major projects follows.

Anaheim

Cable television--Under this project the adviser worked with the city to prepare procurement specifications and a franchise ordinance and also aided in the contractor selection process. The city was planning to start a conventional cable television franchise before the program started; through the adviser's aid it was able to establish a new franchise which could take advantage of cable television's potentially wide variety of services. Included in the Anaheim franchise is the potential for providing (1) direct communication links between citizens and city officials, (2) home access to libraries or other data sources, and (3) a police emergency override of all channels. According to NSF, this capacity could be worth up to $300,000 a year.

Fire source locator (Probeye)--This project addressed the problem created by smoke during fire-fighting operations. The adviser's study, supported by his company, led to identifying Probeye, a hand-held infrared imaging device developed by Hughes Aircraft Company. The device helps to see through smoke and locate the source of fires. After a series of demonstrations and tests, the city council authorized the purchase of a unit which is now regularly used by the fire department.

Fresno

Citizen participation in environmental activities--The purpose was to improve communication and understanding and to aggregate environmentalists' views for policy deliberations. The adviser, through establishing an Environmental Communication Network, brought together a broad representation of Fresno citizens to act as a forum for an information exchange on environmental issues. The network communicated

with city management through the Environmental Coordinator, who is responsible for generating environmental impact statements.

Solid waste management--The purpose was to identify, analyze, and rank various resource recovery processes for the Fresno region. The adviser, with company support, undertook a system analysis of the entire city waste disposal process. The project explored various separating, compressing, and chemical processing techniques yielding a variety of useful products; it included an economic analysis of each technique's strategies. Because of State requirements for regional waste planning, the county assumed responsibility for the study, assisted by Fresno's information resources and adviser.

Pasadena

Pasadena selected a single pilot project called management by objectives (MBO), an achievement-oriented participative method of management. It advocates that the individual employee be aware of how specific tasks are related to the overall organization objectives and of the employee's commitment to perform those tasks in a specified period. The city manager had been interested in using MBO in Pasadena, but was unsure of how to apply it, since most of the previous uses had been in private industry. With the adviser, the city manager was able to work out an implementation plan and the project moved forward. Introducing MBO was accomplished through management seminars conducted by Aerojet personnel. With the adviser's help, each city department developed its own objectives and associated implementation plans. Initially, the process was limited to specific major organizational objectives to familiarize the city personnel with the concept. Ultimately, the aim was to develop a complete plan of operations for each fiscal year, including correlating budgets with management objectives.

San Jose

Priority management program--The purpose was to develop a methodology for assigning priorities to the different city projects to insure the optimum allocation of scarce resources. The adviser, with support from his company, made an extensive

literature search of priority assignment methods which did not depend too much on subjective rankings. Investigation of a promising method revealed that it was still in the theoretical development stage and had not evolved to the point of practical application. The project was discontinued.

Municipal information system--The purpose was to develop an information system using available computer software programs and taking into account the long-term master plan generated by each department's needs. To implement the system, an Electronic Data Processing Steering Committee was formed with the adviser as its chairman. The committee was to prepare and implement a plan to increase the efficient use of computer resources. An implementation plan had been prepared, and the second phase involving detail design and evaluation of other systems was continuing.

Examples of other projects undertaken in the cities are shown in appendix III.

PROGRAM COSTS

As set forth in the proposal and the interagency agreement, NSF funded the advisers' salaries, fringe benefits, relocation, and travel expenses. NASA annually funded JPL activities equivalent to 3 staff-years. Total program costs funded by NSF and NASA for the initial 2 years amounted to about $483,700. NSF funds to pay the advisers' expenses amounted to $269,100. These expenses were paid in the form of reimbursements to the companies for the cost of the advisers and ranged from about $28,000 to $39,000 a year. NASA funds amounting to $214,600 were used to defray JPL salaries, travel, and overhead expenses.

In addition, the industrial firms and cities were required to provide certain services at their own expense. Each company waived the normal application of indirect expenses and profit associated with the adviser's compensation and provided the adviser, annually without charge, back-up technical support to a maximum of 1 staff-year of effort. Each city furnished the adviser, without charge, office space and associated services and the assistance of the city manager and various departmental personnel as required.

Neither the industrial firms nor the cities maintained records to identify support service costs. However, each adviser estimated the support level contributed by the respective cities during the second program year as follows:

Anaheim	[a]$60,300
Fresno	26,600
Pasadena	26,300
San Jose	28,700

[a]Anaheim's estimate included about $25,000 for cost categories not included in the other cities' estimates; i.e., Probeye purchase ($9,240) and overhead expense ($15,535).

CHAPTER 3

PROGRAM ACCOMPLISHMENTS

The California Four Cities Program's total accomplishments are difficult to determine because many of the program's benefits are intangible. They involve such things as a healthy interchange of ideas and concerns among professionals of diverse backgrounds and changes in the city management's attitudes and management styles or procedures. For example, program participants we interviewed said the program has resulted in the cities' being more receptive to change and innovation. These changes are always difficult to measure. They were especially so in this program, because no attempt was made before the program was started to establish the prevailing attitudes in the cities regarding innovation or other managerial behavior indicies. Consequently, our evaluation of the program's accomplishments was directed primarily toward determining the extent to which the six specific program objectives discussed in chapter 2 were achieved.

JPL also evaluated program objective accomplishments primarily on the basis of information obtained from questions submitted to the participating cities, advisers, and companies. To avoid unnecessarily duplicating JPL's efforts, we relied on the information provided to JPL and supplemented it partially with personal interviews with selected program participants.

On the basis of the respective evaluations, we along with JPL, concluded that the Four Cities Program generally achieved the specific program objectives and showed that such partnership arrangements can bring about improvements in operating local governments through technological innovation. A discussion of achievements relative to each specific objective follows.

AEROSPACE PROFESSIONALS' ABILITY TO CONTRIBUTE TO THE CITY

According to city officials, the program demonstrated that the aerospace industrial professional can contribute to the improvement of city management. This is probably best shown by the numerous projects undertaken and completed in each city and the advisers' role in the projects. The advisers, without exception, had managerial experience before participating in the program and in many cases managed the projects for the city managers. For example, the Fresno

adviser managed a project to identify, analyze, and rank various resource recovery processes for the Fresno region.

NATURE AND AMOUNT OF TECHNICAL SUPPORT REQUIRED

The program was designed to provide the adviser with technical support--either from his company or from JPL--to solve specific city problems. The participating industries' progress reports showed that technical support was needed, but they did not establish the specific nature or amount of support required to bring aerospace technology to local governments. Our analysis of these reports indicated that the nature and amount of technical support varied among the industries, depending on such things as the industries' capabilities and the nature of the projects selected by the cities. Generally, support provided by the company involved software (e.g., literature researches, seminars, and studies) rather than hardware.

Regarding this program objective, JPL concluded that "although not all available support was used at each of the cities, its availability is considered key to the program success achieved to date." In other words, knowing that support was available, even though not used, was important to the cities.

EXPOSING CITY PERSONNEL TO THE SYSTEMS APPROACH TO PROBLEM SOLVING

The advisers demonstrated to city personnel the systems approach to solving problems (i.e., defining problems, developing alternative solutions, implementing the best solution and evaluating its effectiveness) through technical efforts--especially through the projects undertaken in the cities. For example, the systems approach was used in San Jose's development of a municipal information system to increase the effective use of computer resources and in Pasadena's enactment of a burglary and robbery alarm ordinance to reduce false alarms. In addition, Anaheim identified the systems approach to problem solving as one of the most important technological advances the program brought to the cities.

EXPOSING AEROSPACE PERSONNEL TO THE SOCIOPOLITICAL PROCESS

NSF and JPL recognized at the program's outset that if the advisers were to be successful in recommending solutions to the cities' problems, they would have to be aware of the powerful social and political influences confronting city

managers. Therefore, the program scheduled an orientation period of 3 to 6 months to provide advisers an opportunity to become acquainted with the cities' personnel and organization. The advisers told us that as the program progressed, they became increasingly exposed to problems restricting technological advances. For example, the advisers encountered obstacles such as the city department heads' reluctance to discuss departmental problems with individuals not in the department, limited funding for development and feasibility tests, and social and political issues in the community that were strong enough to prevent or appreciably delay technological solutions.

Our discussions with the advisers and our analysis of comments made by industry representatives to JPL indicated that familiarizing aerospace personnel with the nontechnical influences facing city officials was a very important lesson to the industries in terms of future business associations with city governments.

APPLICABILITY OF AEROSPACE TECHNOLOGY AND EXPERTISE TO CITY PROBLEMS

As noted previously, the aerospace personnel's expertise resulted in numerous projects aimed at solving pressing city problems. For the most part, the aerospace industry's contributions were in the form of management techniques and problem-solving expertise; i.e., software technology applications. Conversely, aerospace hardware technology applications were practically nonexistent--the one exception being the fire source locator (Probeye) in Anaheim.

According to industry representatives, factors limiting hardware transfers in the four cities were: (1) limited funding available for transfers, (2) the low-risk profile adopted by the cities and industry, and (3) insufficient time.

BENEFITS TO CITY

Our analysis of answers to questions JPL submitted to the cities and of interviews with city officials showed that each city believed it benefited from the program. Benefits cited included:

--Software projects undertaken in the cities, as shown in appendix III.

--Availability of an adviser as a resource with expertise to objectively analyze problems and identify technological solutions.

--Stimulation of a different approach toward conducting city affairs through the systems approach to problem definition and the awareness of technological solution.

--Mutual education process through which the adviser and city officials succeeded in changing their ways of seeking to define problems and identify solutions.

--Probeye.

Although the program has been beneficial to the cities, the benefits are difficult to measure because the projects undertaken in the cities have not always lent themselves to cost/benefit measurements. The usefulness of such measurements was demonstrated in at least one instance by a project in San Jose during which a cost/benefit study was conducted. During that project the city applied mathematical models to study vehicle replacement policies in the police department. The study produced evidence for retaining the current policies after a cost comparison showed that the proposed replacement policy would cost the city over $60,000 a year.

The program did not demonstrate enough tangible benefits during the initial 2-year period to persuade the cities to assume full funding support of the program. However, the program's benefits led to the cities' willingness to continue the program and to each city paying $7,500 of the program expense in addition to the in-kind services provided during the program's first 2 years.

BENEFITS TO INDUSTRY

The participating companies entered the Four Cities Program primarily to define and develop new markets for their industry and as a gesture of social responsibility to the communities. Although each company gained a much better understanding of city government's problems, no tangible business opportunities accrued during the first 2 years. The companies gave JPL the following reasons:

--The program's short timespan which precluded undertaking potentially beneficial projects requiring extensive research and development efforts.

--The problem of market aggregation and how to effectively cope with a decentralized public technology market.

--The type of contracts for technical expertise awarded by cities. These generally are for small dollar amounts and short time periods. Such contracts are not financially attractive to aerospace companies.

--The limited city resources and lack of incentives for high-risk innovative attack on problems which had not yet reached crisis proportions.

Although the companies considered some future business opportunities possible, the opportunities generally related to marketing studies and management systems rather than to hardware.

CURRENT PROGRAM STATUS

Since our review's completion, the California Four Cities Program has evolved into a California-wide technology transfer and innovation network. The original four cities (Anaheim, Fresno, Pasadena, and San Jose) continue to be participants. New participants include the State of California; the cities of Garden Grove, Santa Ana, and Huntington Beach; and the League of California Cities, a Statewide voluntary association of cities. The program's future plans contemplate including the city of Burbank and San Diego City and San Diego county. NSF officials told us that industry support will be provided to all participating cities.

The new program, called the California Innovation Group, is to be managed by the Institute for Local Self Government, the research arm for the League of California Cities and for the County Supervisors Association of California. NASA and JPL are no longer participants.

The new program has about $700,000 in funding for the 1974-75 program year. The cities are contributing cash of $52,500 and support services of about $300,000. The balance comes from three agencies--$207,000 from NSF; $100,000 from the Department of Housing and Urban Development's "701" planning grants[1]; and $30,000 from a Federal Energy Administration's grant which was pending at the time of our study.

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[1]"701" is the designation given by Housing and Urban Development to one of its major technical assistance programs.

In recognition of experience gained during the initial program, certain changes were made, including:

--A policy board, established in June 1973 and composed of city managers as voting members, to determine the program's policy direction and to provide for greater program involvement by city officials.

--A liaison program between State and local governments' science and technology organizations. The purpose was to create a mechanism to facilitate local participation in developing State and Federal research and development programs and priorities for dealing with local governments' problems.

--A research dissemination program to identify and communicate Federal- and State-sponsored research useful to local governments.

--A public information program to bring an awareness of technology's value to various community segments.

--Joint projects to be undertaken when one city is willing to take the lead role on a specific task and one or more other cities are willing to participate. The policy board has established the energy area as the priority joint project.

--Regular monthly meetings of the advisers and the principal investigator (project manager) to achieve more effective communication.

CHAPTER 4

BARRIERS TO TECHNOLOGY TRANSFER AND LESSONS LEARNED

One objective of our Four Cities Program study was to formulate some general observations on technology transfer programs which may relate to future efforts to apply technology to urban problems. Our observations are presented in terms of barriers to technology transfer and lessons learned from the transfer process used in the Four Cities Program. They illustrate that bringing technology into the cities is a complex and long-term process.

BARRIERS TO TECHNOLOGY TRANSFER

Social, political, and economic constraints to public sector technology transfer and innovation

Many times city problems cannot be resolved through technology alone. Social, political, and economic factors must be weighed when defining problems and seeking solutions in communities with diverse interests. These nontechnological influences often represent major barriers to technological solutions to public problems. Therefore, community involvement and approval are necessary for technological projects which directly affect the residents.

For example, local residents opposed the proposed location for a new Pasadena police helicopter landing site, despite the location's economic advantages and a noise level survey conducted by JPL engineers. The survey suggested that heliport use should not greatly exceed noise levels anticipated from a new freeway being built in the same location as the heliport. Although at the time of our study it appeared that the city would approve the landing site, the project was appreciably delayed because of community opposition.

Market aggregation needed to stimulate industry investment in public technology

The aerospace companies were not willing to invest capital in researching solutions to city problems when they were unsure whether a sufficient market existed to justify their investment. According to company representatives, this market uncertainty was one of the most

important barriers to applying industry resources and technology to city problems.

The following company statements to JPL indicate the need for market aggregation to obtain industry investment in public technology.

--Components such as remote meter readers and reservoir level monitors, which would be beneficial to the cities, could have been engineered; however, such products were not in the ready-to-market stage. The additional engineering and development were outside the scope of the contractual arrangement to provide backup support and would not be undertaken without a ready market.

--A meaningful public technology approach should address urban problems and requirements definition on a regional basis. The regional requirements could be aggregated and made available to industry for market analysis. Further, determining requirements on a national level would establish a basis for research and development funding by industry to solve critical city problems.

--Public technology would best be approached through a massive infusion of Federal funds to solve specifically defined national problems by expert teams. The broad-based approach to public technology would create the necessary market aggregation.

--Hardware transfers in the Four Cities Program were very difficult. Consolidating potential markets is necessary to provide the profit motive which was lacking due to the low-key funding provided in the program.

Low-risk profile on research and development activities

The cities consider research a risky proposition with small rewards for success and considerable adverse exposure--in cases of unsuccessful efforts--to officials seeking reelection. Since research projects have to compete for limited funds with ongoing city operations, many of which have demonstrable benefits, there is little incentive to take risks on unproven techniques or hardware development.

The Probeye unit (see p. 9) exemplifies the funding constraints in transferring aerospace technology to city government. Although the cities were interested in acquiring the unit, they were reluctant to fund the necessary feasibility demonstrations for operational development. Only Anaheim conducted feasibility tests and eventually acquired a unit with city operating funds, but only after many funding sources outside the city were pursued.

The low-risk profile adopted by the cities will remain a barrier to public sector technology innovation until technology benefits can be shown to outweigh costs. One way to accomplish this in future efforts to bring technology to local governments is to select projects for which cost/benefit measurements are possible. As stated in chapter 3, these types of projects were not always used in the Four Cities Program.

LESSONS LEARNED FROM THE TRANSFER PROCESS USED IN THE FOUR CITIES PROGRAM

Hardware technology more difficult to transfer than software

All but one of the projects undertaken by city/company teams dealt primarily with software. While recognizing that transferring any technology from industry to cities is difficult, we believe that major hardware technology generally is more difficult, from the cities' viewpoint, to transfer than software for the following reasons:

--Hardware usually requires some kind of adaptive engineering, that is, redesigning to fit the requirements of its new use.

--Hardware is frequently more expensive. For example, a training class in a new management technique costs less than redesigning or building major hardware.

--A major hardware transfer may require not only the hardware itself, but also related software changes and supporting activities, such as maintenance systems.

Notwithstanding the difficulty and expense of effecting hardware transfers, such transfers are useful for demonstrating tangible benefits. Demonstrating such benefits lessens the problem of sponsoring and accepting a program, but gaining the opportunity to demonstrate involves

risking resources and the consequences of failure. The cities and their advisers were faced, therefore, with the paradoxical problem of, on the one hand, getting more hardware transfers to gain sponsorship and, on the other hand, getting sponsorship for more hardware.

Strong city manager support necessary

City manager support was a key ingredient to successfully using aerospace technology. The leadership role played by the city manager in identifying problems and seeking solutions exerted a strong influence on the department heads' attitudes. Without strong support from the managers, the various city councils may not have appropriated even limited funds for the program's renewal phase.

The city managers' concern for the program and their desire to exercise greater responsibility for managing the effort led to establishing in June 1973 the policy board referred to on page 18.

Advisers should be assigned to city manager's staff

To help develop the long-term interest and support needed to foster and make routine the application of new ideas and methodologies, advisers should be assigned to the city manager's staff, rather than to a department. The advisers told us that this organizational arrangement enabled them to

--deal effectively with a wide spectrum of city operations and to have access to all city departments;

--deal directly with department heads, whose support is essential for successfully implementing projects;

--have the city manager's backing to obtain the authority and sponsorship needed to shorten the transfer process.

Advisers must be able to establish effective working relationships with city officials

Developing effective personal relationships is one of the single most important aspects of the technology transfer process. For example, unless city officials are receptive to technology, the most dramatic and innovative

developments will most likely fail to be implemented. The reception afforded new ideas and developments depends to a great extent on the city officials' trust and confidence in the industry advisers--both on a personal and a technical basis.

To successfully introduce technology in the cities, the advisers must be able to convince city officials of the benefits from technological innovation so that the officials are willing to surface their problems for technological solution. In addition, the advisers must be highly motivated toward accomplishing program objectives and be capable of maintaining the same motivation in city management.

In selecting industry advisers as technology transfer agents, therefore, care must be taken to insure that they possess the necessary behavioral science and interpersonal relations skills to establish and maintain effective relations with city officials.

Effective communication links needed among advisers

The advisers must be able to communicate among themselves for their mutual benefit. Advisers in the Four Cities Program told us that periodic working sessions would have been beneficial for exchanging and capitalizing on each other's experiences, problems, and techniques.

Although quarterly review meetings were conducted throughout the program's initial 2 years, several advisers told us that the meetings did not result in a cooperative partnership of the advisers' learning from each other's experiences. The meetings were highly structured and were attended by many program participants. For the most part, presentations were made, accentuating the positive accomplishments within each city.

During the program's latter stages, the advisers took more initiative to discuss problems and exchange ideas of mutual concern among themselves. In addition, as discussed on page 18, the program's extension phase provides for monthly meetings of the advisers, which should enable more effective communication.

Early definition of management responsibilities essential in multiagency program

Although NSF, NASA, and JPL each were aware of the stated program objectives, there was some uncertainty about their respective management responsibilities--especially regarding the extent to which the program's results were to be publicized. Although the uncertainty did not prevent achieving the program objectives, we believe that, from the standpoint of good management practices, steps should have been taken at the program's outset to define the management roles of each participating agency. Neither the program proposal nor the interagency agreement authorizing the program clearly defined those roles.

NASA's traditional operational pattern has been to undertake assignments to gain specific information within a predetermined time frame. Consistent with that pattern, NASA's Technology Applications Office viewed its role in the Four Cities Program as being of limited duration to determine an aerospace professional's value to the cities; i.e., for NASA the program meant conducting an experiment. Our discussions with JPL officials indicated that they shared NASA's view. Consequently, NASA and JPL were cautious about providing publicity and promotion until the experiment was completed.

In contrast, NSF's Office of Intergovernmental Science and Research Utilization, which has a continuing mission to support intergovernmental science, sought a program which would have national impact; i.e., one which would demonstrate the tangible benefits of the science adviser approach. NSF, therefore, wanted to continually disseminate the program's results while it was operational to convince additional cities of this program's value.

In addition, during early program meetings, NSF indicated that it expected JPL to exercise more of a leadership role in providing guidance and direction to city officials and industry advisers in selecting projects to be undertaken. JPL, however, viewed its management role as one of communication and interface with NSF/NASA and of providing administrative support to the cities and advisers, as stated in the program proposal. For the most part, JPL did not provide policy or procedural guidance in the program since it wanted the advisers to make the day-to-day decisions.

We believe that the uncertainty experienced in the Four Cities Program indicates the need, in multiagency programs of this nature, to establish in the initial program planning a discussion of each program participant's management responsibilities.

CHAPTER 5

CONCLUSIONS, RECOMMENDATIONS, AGENCY COMMENTS, AND MATTERS FOR CONSIDERATION BY THE CONGRESS

CONCLUSIONS

Generally, the Four Cities Program met the stated specific program objectives. Still left unanswered, however, is the specific nature and amount of technical support required to bring aerospace technology into local governments. In addition, NSF, NASA, and JPL were somewhat uncertain about their respective management roles regarding the dissemination of program results.

The program showed that partnership arrangements can bring about improvement in local governments. The improvement comes mainly in the change of city managements' attitudes toward technology and their awareness of technology and its potential. The extent of the attitudinal changes is not known, however, because no attempt was made to determine management attitudes toward technology at the program's start.

The projects undertaken during the program did not always lend themselves to cost/benefit analyses. Due to the lack of demonstrable benefits, the cities were not willing to support the Four Cities Program alone. However, the cities decided to participate in an extension of the program and to increase their financial support. Capitalizing on the experiences of the initial program, the extension phase has been modified to obtain greater involvement at the State level, more direction by the city managers, more effective communication among the industry advisers, and broader dissemination of program results to other nonparticipating cities.

Our Nation's cities are faced with numerous problems, such as law enforcement, fire prevention, education, housing, environmental pollution, public transportation, and water quality. The Four Cities Program showed that technology can help alleviate city problems. There are, however, a number of major barriers to introducing and using science and technology in the cities, such as:

--Social, political, and economic factors can prevent or appreciably delay applying technological solutions.

--Success is never assured, and getting city officials to accept the possibility of failure is never easy.

--City officials need assurance that tangible benefits will result from technology applications; but before tangible benefits can be realized, they must be willing to risk resources and accept the consequences of failure.

All these problems indicate that bringing technology into the cities is a complex and long-term process.

The cities and industries participating in the program were given an opportunity to provide written comments on our report.[1] Generally, they agreed with our conclusions; most of them expressed satisfaction with the program's accomplishments and usefulness. The complete comments of the cities and industries are presented in appendixes VII and VIII.

RECOMMENDATIONS TO THE DIRECTOR OF NSF

We recommend that the Director, NSF:

--Emphasize the need to measure participants' attitudinal changes, such as increased receptivity to technology, in future programs to apply science and technology to urban problems.

--Require, to the extent practicable, that criteria for selecting projects to be undertaken during such programs include the possibility of making cost/benefit measurements.

--Require that the program-planning phase of multi-agency programs include defining the specific responsibilities of each program participant.

These responsibilities should be detailed in the documents governing the program's operation.

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[1]Anaheim and Northrup did not furnish comments.

AGENCY COMMENTS AND OUR EVALUATION

NSF agreed with our recommendations and stated that they would be adopted in future technology transfer projects like the Four Cities Program. (See app. V.) In contrast, NASA disagreed with our views on the need to measure participants attitudinal changes and the need for cost/benefit measurements. NASA did not comment on our third recommendation. (See app. VI.)

Regarding the measurement of attitudinal changes, NASA stated:

> "We do not agree that attitudinal changes are a valid measure of the utility of programs such as this, or of follow-on programs. The attitudes of those who have participated in such a program are indeed important indicators of the value of the program--but the existence or lack of a change in attitude is not necessarily relevant. In this program, the participants were, at a minimum, 'receptive' initially, and their experience in the program has apparently only served to reinforce this attitude rather than to change it. The real measure of utility of a technology transfer program lies in the extent to which the users gain useful knowledge or adopt and use improved processes, techniques, or hardware as a result of the program. To call for emphasis on measurement of attitudinal changes is, we believe, to invite distraction from the real issues involved."

The extent to which program participants gain useful knowledge or adopt and use improved processes, techniques, or hardware certainly is an important measure of a program's results, but it is not, as NASA suggests, the only real measure. Measuring attitudinal changes is also a valid and important concern. In fact, changes in attitude are necessary in many cases, before program participants will be willing to adopt new processes or practices, even if the participants are initially receptive to the idea of being involved in a transfer program.

In our view, being receptive to a program differs notably from being receptive to changes in processes or practices. The latter attitude, we think, warrants measurement on a before-and-after-the-program basis. NSF recognizes, as we do, the difficulty in measuring attitude change, but it agreed to try to obtain such measurements in its future programs.

NASA also disagreed with our recommendation that NSF require, to the extent practicable, that criteria for selecting projects to be undertaken during such programs include the possibility of making cost/benefit measurements. NASA stated that although assessing economic or other benefits is desirable and should be included in evaluating candidate projects, it believed that a project's cost/benefit measurement potential should not be a selection requirement.

We know that cost/benefit analyses are often difficult and in some cases not possible. We believe, however, that to the extent possible they should be made. Such measurements and the dissemination of the resulting information would be particularly useful in programs similar to the Four Cities Program to help demonstrate to nonparticipating cities the potential for solving local governments' problems through applying technology. NSF stated that cost/benefit measurements will be attempted in future technology transfer programs.

We believe that the actions to be taken by NSF will greatly help in applying technology to the problems of local governments.

MATTERS FOR CONSIDERATION BY THE CONGRESS

The Congress has had a continuing interest in Federal experimental programs designed to better use science and technology to help solve the problems of State and local governments.

In addition to the Four Cities Program, the Federal Government is sponsoring other experimental programs--such as the Department of Housing and Urban Development's Urban Observatory Program--to try to apply technology to local governments' problems. Programs of this nature will continue to be implemented. For example, the Solar Heating and Cooling Demonstration Act of 1974 (42 U.S.C. 5501) provides for a joint NASA, the Department of Housing and Urban Development, National Bureau of Standards, and NSF program for developing and demonstrating solar heating systems for use in residential dwellings. The Congress should use this report in reviewing and evaluating ongoing and proposed programs to apply science and technology to help solve State and local government problems.

CHAPTER 6

SCOPE OF REVIEW

We made our study at NSF and NASA headquarters in Washington, D.C.; the Jet Propulsion Laboratory in Pasadena, California; Anaheim, Fresno, Pasadena, and San Jose; and the facilities of the four companies (Aerojet, Lockheed, Northrop, and Science Applications, Inc.) which provided technical support during the program. We reviewed records relating to program planning, management, funding and reporting, and to the activities of the program participants. In addition, we reviewed the JPL report on its program evaluation.

We held discussions with NSF, NASA, and JPL officials; science and technology advisers; and city and industry representatives to (1) determine the practices followed in identifying and applying technology to city problems, (2) assess program accomplishments, and (3) identify barriers to technology transfer.

EXCERPTS FROM THE PRESIDENT'S SCIENCE AND TECHNOLOGY MESSAGE TO THE CONGRESS, MARCH 16, 1972

The ability of the American people to harness the discoveries of science in the service of man has always been an important element in our national progress. * * *.

* * * * *

But the accomplishments of the past are not something we can rest on. They are something we must build on. I am therefore calling today for a strong new effort to marshal science and technology in the work of strengthening our economy and improving the quality of our life. And I am outlining ways in which the Federal Government can work as a more effective partner in this great task.

* * * * *

In pursuing this goal, it is important to remember several things. In the first place, we must always be aware that the mere act of scientific discovery alone is not enough. Even the most important breakthrough will have little impact on our lives unless it is put to use--and putting an idea to use is a far more complex process than has often been appreciated. To accomplish this transformation, we must combine the genius of invention with the skills of entrepreneurship, management, marketing and finance.

Secondly, we must see that the environment for technological innovation is a favorable one. * * *.

Thirdly, we must realize that the mere development of a new idea does not necessarily mean that it can or should be put into immediate use. * * *.

A fourth consideration concerns the need for scientific and technological manpower. * * *.

The fifth basic point I would make concerning our overall approach to science and technology in the 1970's concerns the importance of maintaining that spirit of curiosity and adventure which has always driven us to explore the unknown. * * *.

Finally, we must appreciate that the progress we seek requires a new partnership in science and technology--one which brings together the Federal Government, private enterprise, State and local governments, and our universities

APPENDIX I

and research centers in a coordinated, cooperative effort to serve the national interest. Each member of that partnership must play the role it can play best; each must respect and reinforce the unique capacities of the other members. Only if this happens, only if our new partnership thrives, can we be sure that our scientific and technological resources will be used as effectively as possible in meeting our priority national needs.

* * * * *

STRENGTHENING THE FEDERAL ROLE

* * * * *

In this message, however, I would like to focus on how we can better apply our scientific resources in meeting civilian needs. Since the beginning of this Administration, I have felt that we should be doing more to focus our scientific and technological resources on the problems of the environment, health, energy, transportation and other pressing domestic concerns. * * *.

* * * * *

STRONGER FEDERAL, STATE AND LOCAL PARTNERSHIPS

A consistent theme which runs throughout my program for making government more responsive to public needs is the idea that each level of government should do what it can do best. This same theme characterizes my approach to the challenges of research and development. The Federal Government, for example, can usually do a good job of massing research and development resources. But State and local governments usually have a much better "feel" for the specific public challenges to which those resources can be applied. If we are to use science and technology effectively in meeting these challenges, then State and local governments should have a central role in the application process. That process is a difficult one at best; it will be even more complex and frustrating if the States and localities are not adequately involved.

To help build a greater sense of partnership among the three levels of the Federal system, I am directing my Science Adviser, in cooperation with the Office of Intergovernmental Relations, to serve as a focal point for discussions among various Federal agencies and the representatives of State and local governments. These discussions

should lay the basis for developing a better means for collaboration and consultation on scientific and technological questions in the future. They should focus on the following specific subjects:

1) Systematic ways for communicating to the appropriate Federal agencies the priority needs of State and local governments, along with information concerning locally-generated solutions to such problems. In this way, such information can be incorporated into the Federal research and development planning process.

2) Ways of assuring State and local governments adequate access to the technical resources of major Federal research and development centers, such as those which are concerned with transportation, the environment, and the development of new sources of energy.

3) Methods whereby the Federal Government can encourage the aggregation of State and local markets for certain products so that industries can give government purchasers the benefit of innovation and economies of scale.

* * * * *

EXCERPTS FROM THE PRESIDENT'S STATE OF THE UNION MESSAGE TO THE CONGRESS JANUARY 30, 1974

* * * * *

THE NEW FEDERALISM

Just as the rapidly changing and increasing demands placed upon Government have made it necessary to reorganize the Federal structure, they have made it even more imperative to make State and local government stronger and more effective.

During the last four decades, almost every major attempt by the Government to meet a major social need has resulted in a new national program administered in Washington by a new bureaucracy. * * *. This growth in size, power, and complexity has made the Federal Government increasingly inaccessible to the individual citizen it seeks to help.

Many of our new national social programs have actually impeded the development of effective local government. By creating a Federal categorical grant system of staggering complexity and diversity we have fostered at the State and local level:

--Overlapping and wasteful programs;

--Distorted budgets and priorities;

--Additional administrative expense;

--Delay and uncertainty; and

--A diminution in the authority and responsibilities of State and local elected officials, as Federal grants have become the special province of competing bureaucracies.

In one of the basic new directions of my Administration, I proposed in 1969 that we create a new and fundamentally different relationship between State and local government, on the one hand, and the Federal Government on the other.

This new relationship has come to be known as the New Federalism. As I said in 1969, its purposes are:

--To restore to the States proper rights and roles in the Federal system with a new emphasis on local responsiveness;

--To provide both the encouragement and necessary resources for local and State officials to exercise leadership in solving their own problems;

--To narrow the distance between people and the Government agencies dealing with their problems;

--To restore strength and vigor to State and local governments where elected officials know best the needs and priorities of their own constituents; and

--To shift the balance of political power away from Washington and back to the country and the people.

* * * * *

In the remaining three years of this term I shall continue to take every sound administrative action within the authorities available to me to support and strengthen State and local government, but we must have the support of the Congress to maintain the progress which has begun.

* * * * *

SUMMARY OF THE TECHNOLOGY ACTIVITIES MANAGED OR CONDUCTED BY THE ADVISERS

In addition to the projects discussed in the body of the report, the following are examples of other projects undertaken in each city.

Anaheim

--Command and control - This project's purpose was to establish a unified communication and control system linking police, fire, disaster services and possibly elements of other departments. Although technically feasible, this project was terminated when the fire departments adopted a regional approach with other municipal fire departments in the county.

--Investigating the application of mathematical models for use in equipment and vehicle replacement and repair policies. The city accepted the adviser's recommendation for using the Public Technology, Inc., model and plans to implement the technique for future decision-making.

--Supporting a program with Harvey Mudd College involving application of the MIT Urban Dynamics computer model to determine its usefulness in decisions regarding future city development. The project is continuing at the present time.

--Assisting the City Data Processing Steering Committee in formulating guidelines used to prepare a master plan for data processing facility operations.

Fresno

--CATV - The objective was to develop a community use plan for CATV and to set up a process for continued liaison with all organizations involved during construction. The adviser is managing the city's role in the installation, startup and effective use of the system. The project is operational at the present time.

--Internal reporting system - The objective was to design and implement a project status report for information flow from department head to City Manager to City Council. The adviser developed a quarterly project report format which presented the essential facts obtained from working levels in the departments for use by the City Manager and other officials. The reporting system has been adopted by the city.

--Regional planning policy - The project was to define the city policy relative to the regional planning process. As a task force chairman, the adviser published three documents relating to various aspects of regional planning which were accepted by the city. These studies led to a recommendation for substate planning districts for the Central Valley Basin formulated with the local chapter of the League of California Cities and presented to the State for review and implementation.

--Studying and developing a mathematical model for vehicle replacement. It was used in Fresno to justify longer retention of vehicles, thereby deferring capital expenditures estimated at more than $200,000 the first year and $100,000 the second year.

--Identifying supply sources and procuring sound measurement devices to improve noise ordinance enforcement. The adviser also instructed city personnel in using the equipment.

Pasadena

--Assisted the Police Department in establishing a heliport site within the city limits. Housing and maintaining police helicopters 22 miles from Pasadena reduced patrol effectiveness to about 40 percent of available time. The adviser assisted the Police Department with the analysis of requirements, noise surveys by JPL, site survey studies, preparation of presentations to the Land Use Committee, Planning Commission, and City Council. After approval was obtained, further assistance was provided for detailed planning, including environmental impact studies and construction planning.

--Assisted the Police Department in the analysis of requirements and preparation of material presented to the City Council for enacting a burglary and robbery alarm ordinance to reduce false alarms. City Council approval for enactment was obtained. False alarms have been reduced 40 percent resulting from the enacted ordinance.

--Assisted the Fire Department in presentations before the City Council to relocate one fire station displaced by a new freeway. The adviser assisted in the analysis of locations to provide more equitable coverage and to effect consolidation made possible as a result of improved equipment capability. The relocation was approved.

--Assisted the Department of Water and Power with a presentation to the City Council requesting approval of a specification for gas turbine generators and a call for bids. The adviser assisted in the requirements analysis for gas turbines for peaking power, prepared materials, and assisted department personnel in presentations to the City Council which resulted in approving the specification.

--Assisted the Health Department in planning, preparing, and presenting material to the City Council for enacting a noise ordinance which was approved.

San Jose

--Organized a series of seminars presented by Lockheed to promote an awareness of existing technology.

--Assisted the city planning director in investigating the applicability of the MIT Urban Dynamics computer model. Although the simulation results did not produce the desired results, the exercise was useful in demonstrating the potential of such a model in assisting the city in decisions regarding future development.

SUMMARY OF OTHER NSF TECHNOLOGY TRANSFER MODELS

Since late 1971, the NSF Intergovernmental Science Program has been aimed at placing science and technology advisers within, or in close association with, the chief executive's office of municipal government. For this purpose, NSF chose communities with populations ranging from a few thousand to a major metropolis, in geographical location from southern Alabama to the west coast, in political structure from the traditional mayor-council to the manager-council.

The program includes four basic models:

1. The Academic Public Service Model--Based at Auburn University, a land grant institution in Auburn, Alabama, the program uses the School of Engineering as the backup support for two full-time engineer extension field agents, one working in Anniston (population 35,000) and the other with four towns (population 5,000 and less) in Geneva County.
2. The Industry/City Model--Four Cities--This model is the subject of this report.
3. The Self-Initiated Institutional Change Model--A full-time, industry-trained technology coordinator on the city payroll in Tacoma, Washington, acts as a broker between the operating agencies (which have the responsibility and management incentives to seek outside technology resources in industry), universities, and the State and Federal Government. A team of engineers from a nearby Boeing plant provides close-in technology expertise. The company also has contributed additional manpower and resources for specific projects.
4. The Voluntary Public Service Model--This model, practiced in Philadelphia, Pennsylvania, employs a Science and Technology Advisory Council to the the Mayor rather than an industry engineer or scientist working in the city government. The council consists of volunteers from Philadelphia's large reservoir of research institutions, universities, and high technology industry. A small staff attached to the Mayor's office provides a bridge between the council and the operating agencies.

5. Urban Technology System--This is a program, managed by Public Technology, Inc., whereby scientists and engineers acting as technology agents will be assigned to the staffs of 27 city and county governments (population 50,000 to 500,000) across the United States. The transfer agents will attempt to identify problems that local jurisdictions find most pressing and then seek out the best and most economical technology available to solve the problems. The transfer agents will help adapt technology to the problems through technical support from 15 participating research and development organizations (universities, research and development centers, and private corporations).

NATIONAL SCIENCE FOUNDATION
WASHINGTON D C 20550

nsf

OFFICE OF THE
DIRECTOR

MAY 20 1975

Mr. Gregory J. Ahart
Director
Manpower and Welfare Division
United States General
Accounting Office
Washington, D.C. 20548

Dear Mr. Ahart:

I very much appreciate your thoughtfulness in giving the Foundation the opportunity to review the General Accounting Office's draft report to the Congress, entitled "Technology Transfer and Innovation in the Public Sector; The California Four Cities Program."

I was pleased to learn that your review concluded that the program generally had achieved its stated objectives. I was particularly pleased to have the benefit of recommendations concerning the need to measure more rigorously participants' changes in attitudes; to select measurement criteria and techniques that lend themselves to more precise estimates of benefits and costs; and to define clearly the specific responsibilities of each of the organizations participating in the program. I have instructed Foundation staff to see to it that each of these recommendations is followed in any subsequent programs of this type. I realize, as I am sure you do, that estimating ultimate benefits and costs as well as changes in attitudes attributable to relatively small programs is difficult. Nonetheless, I see no reason why both measures of attitudinal change and measures of benefits and costs cannot be obtained.

As the report makes clear, we have much to learn about the processes and outcomes of applying technology to deal with immediate problems of U.S. cities. For example, we need to know much more about the specific conditions under which various types of technology are adopted and adapted by cities. A view somewhat at variance with the report, but

Mr. Gregory J. Ahart

one for which there is empirical evidence, is that the transfer of "hardware" is usually less difficult than the transfer of "software," such as new techniques of management. The latter imply organizational changes as well as possible changes in personnel. Future projects, when evaluated according to the recommendation contained in the report, should provide a much sounder basis than is now available for determining the critical circumstances affecting the transfer of various technologies.

Again, I appreciate the opportunity to review the report and welcome assessments of the Foundation's programs. I assure you that the major recommendations of your report will be very carefully considered in future technology transfer projects.

Sincerely yours,

H. Guyford Stever
Director

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO
ATTN OF: W

APR 29 1975

Mr. R. W. Gutmann
Director, Procurement and
Systems Acquisition Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Gutmann:

This is in response to your February 26th letter to the Administrator concerning the draft GAO report entitled, "Technology Transfer and Innovation in the Public Sector - The California Four Cities Program" (Code 952041). The views of the Jet Propulsion Laboratory were considered in the preparation of the enclosed comments.

[See GAO note, p. 46.]

Sincerely,

Duward L. Crow
Assistant Administrator for
DOD and Interagency Affairs

Encl.

APPENDIX VI

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

COMMENTS ON

U. S. GENERAL ACCOUNTING OFFICE DRAFT REPORT

ON

"TECHNOLOGY TRANSFER AND INNOVATION IN THE

PUBLIC SECTOR - THE CALIFORNIA FOUR CITIES PROGRAM"

(CODE 952041)

These comments confirm the principal points made in our discussion with Mr. Meisner and other representatives of the General Accounting Office on March 27, 1975. The comments also take into account the views expressed by the Jet Propulsion Laboratory on the draft report.

Experimental Program

The draft report, particularly in the DIGEST, does not adequately reflect the fact that the program was essentially an experiment. Although the draft report does refer to the program as an "experiment" (e.g., page 2), the burden of the report treats the program as an operational project intended to achieve quantifiable goals (e.g., page 3).

Hardware Transfers

The draft report correctly notes that only one transfer involving adoption of new hardware occurred in the program, and the draft report concludes (page 4) that hardware transfers are inherently difficult to achieve. We believe this conclusion is misleading in its implication that non-hardware, or software, items are inherently easier to transfer. We believe that any transfer (hardware or software in the form of processes, procedures,

or techniques) which requires the city to expend funds or to substantially modify its major operating elements or systems, or which directly affects the citizens, is difficult to achieve. The several successful non-hardware transfers cited in the report lie in the general area of planning or improved decision-making processes -- functions which most likely do not require new expenditures or changes in operating systems (trash collection, law enforcement, fire fighting, etc.) or directly affect the citizens.

Relation to Solar Heating and Cooling Demonstration Program

The report (page 5) suggests that the above program may be a beneficiary from the experience gained in the Four Cities Program. We believe there is no significant relation between the two activities.

Measuring Attitudinal Changes

The draft report refers to the absence of measurements of attitudinal changes during the program (page 3) and recommends that such measurements be emphasized in future programs (page 5). We do not agree that attitudinal changes are a valid measure of the utility of programs such as this, or of follow-on programs. The attitudes of those who have participated in such a program are indeed important indicators of the value of the program -- but the existence or lack of a change in attitude is not necessarily relevant. In this program, the participants were, at a minimum, "receptive" initially, and their experience in the program has apparently only served to reinforce this attitude rather than to change it. The real measure of utility of a technology transfer program lies in the extent to which the users gain useful knowledge or adopt and use improved processes, techniques, or hardware as a result of the program. To call for emphasis on measurement of attitudinal changes

is, we believe, to invite distraction from the real issues involved.

Project Selection Criteria

The draft report recommends (page 5) that criteria for selecting projects to be undertaken include cost/benefit measurement. A fundamental of successful technology transfer is to give the user what he needs -- whether that is measurable or not. Assessing economic or other benefits is indeed desirable, and an assessment of the benefits to be expected should be included in evaluation of candidate projects. However, we believe susceptibility to cost/benefit measurement should not be a requirement for project selection.

[See GAO note.]

for Edward Z. Gray
Assistant Administrator for Industry
Affairs and Technology Utilization

Date: APR 25 1975

GAO note: The deleted comments relate to matters which are discussed in the preliminary report but omitted from this final report. They refer to the preliminary report this agency reviewed.

APPENDIX VII

FRESNO
CALIFORNIA CITY HALL • 2326 FRESNO STREET • FRESNO, CALIFORNIA 93721 • 266-8031

May 8, 1975

Mr. R.W. Gutmann, Director
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Gutmann:

The following comments are offered, in accordance with your request, on your draft report "Technology Transfer and Innovation in the Public Sector - The California Four Cities Program."

The City of Fresno has participated in this program since its start in 1971, and is still participating in the California Innovation Group - the current matured form of the original Four Cities Program. As a consensus opinion, the program must be considered beneficial to the City. It has brought us new technological options, and exposed operating managers to the expanded and effective planning logic characteristic of the aerospace industry. The Advisor and his firm have performed well, and the firm has yet to realize any financial return from the program except coverage of direct costs. The city's positive reaction to the program is evidenced by its willingness to cost-share the program renewal from general fund revenues.

I would like to offer two comments that address areas demanding future attention -- one external to the city and one internal. The first is the matter of the budget available to federal agencies to support and demonstrate the utilization of technology by local governments. For example, the National Science Foundation budget shows approximately $80 million for development of technical solutions, and $1 million for research utilization programs. The problem is not seen at local level as having that bias. We would profit immensely from better utilization of existing technology, and see short-term benefits available from such a course. Further, continued interest in participating in (and supporting financially) a technology utilization program depends on short-term tangible benefits, and not long-term implicit improvements

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in overall professionalism. I therefore urge that some review be made of the funds available to support utilization experiments, with clear objectives of short-term results.

Secondly, with regard to Fresno's participating in a technology utilization program, Fresno plans to take an active role in receiving and using technology, with the involvement and full cooperation of operating departments.

Your draft report is well done, and I look forward to receiving a copy of the final.

Sincerely,

R. W. Hanley

Ralph W. Hanley
Chief Administrative Officer

RWH/jk

APPENDIX VII

City of Pasadena
ONE HUNDRED NORTH GARFIELD AVENUE
PASADENA, CALIFORNIA 91109

March 17, 1975

DONALD F McINTYRE
CITY MANAGER

The United States General Accounting Office
Washington, D.C. 20548

Attention: Mr. R. W. Gutmann, Director
Procurement and Systems Acquisition
Division

Dear Mr. Gutmann:

We have reviewed with interest the draft report entitled "Technology Transfer and Innovation in the Public Sector - The California Four Cities Program."

We find the report to be accurate and realistic in its appraisal of the Four Cities Program effectiveness. Additionally, the judgments which were made with regard to the relative importance of the numerous factors involved in technology transfer are in general consonance with our thinking and should be useful for others who may be entering into such a venture.

If we can be of further assistance to you in this matter please advise.

Sincerely,

DONALD F. McINTYRE
City Manager

DFMcI:FW:cw

APPENDIX VII

CITY OF SAN JOSE
CALIFORNIA

CITY MANAGER

801 N FIRST ST.
SAN JOSE CA 95110
TELEPHONE (408) 277-4000

March 11, 1975

Mr. R. W. Gutmann
Director, United States General Accounting Office
Washington, D. C. 20548

Dear Mr. Gutmann:

Thank you for the opportunity to review the report on the California Four Cities Program before issue in final form. I find it concise, well written, and accurate, and have very little to add; I hope what does follow will be useful.

The report seems to stress working on programs which lend themselves to cost benefit measurements. Many city, and I am sure federal programs, don't lend themselves readily to evaluation on such a basis. Some of those in the city would be the public safety functions on which we spend considerable funds and yet have no exact way for offsetting their costs with benefits on a dollar basis, but we know quite well that our citizens do want public safety services. Even less quantifiable are the services of the planning department or the building department; nonetheless we have all agreed both are useful city functions for which we no longer need make an attempt to have benefit cost justifications. I believe that in time to come the technology function in cities will come to be accepted; it took much time for the public safety function or the public works function to be accepted as a city responsibility.

If you feel that benefit/cost elements should be stressed, I believe you might place more prominence on the one conducted in San Jose which implied a savings of $60,000 a year on vehicle replacement and which is relegated in your report to an appendix. Our entire computer implementation program was based on an analysis of probable benefit/cost relationships for which we made dollar estimates which we can make available to you.

I am pleased that your review of the program is supportive; much will be necessary in the way of aid from Congress for years to come until the function is fully and widely accepted.

Sincerely,

Ted Tedesco
City Manager

TT:jwc

Jack L. Heckel
President

Aerojet
Liquid Rocket
Company

P.O. Box 13222
Sacramento,
California 95813

10 March 1975

Mr. R. W. Gutman, Director
Procurement and Systems Acquisition Division
United States General Accounting Office
441 G Street, N.W., Room 6079
Washington, D. C. 20548

Dear Mr. Gutman:

We have reviewed the draft report to the Congress entitled "Technology Transfer and Innovation in the Public Sector - The California Four Cities Program" and found it to be both accurate and perceptive.

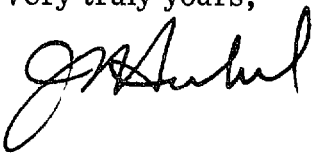
There are two areas which, in our judgement, warrant comment. The first is the recommended emphasis on cost/benefit measurement as a criterion for project selection (page 5). The second is the organizational responsibility for project selection (page 33).

The transfer of management techniques and problem solution methodology (systems approach) can provide great long term benefits to city government. Yet these areas are probably the most difficult to measure on a quantitative basis. It is suggested that future programs be structured to not only allow, but foster this kind of transfer even though cost/benefit measurement is difficult.

It is our opinion, and recommendation, that the primary responsibility for the selection of projects should rest with the city to insure the involvement of city management and to focus on solutions to problems which are considered important by the participating cities.

Please accept our compliments on an excellent report which I am confident will be useful to the Congress.

Very truly yours,



APPENDIX VIII

Lockheed
PALO ALTO
RESEARCH
LABORATORY

3251 HANOVER STREET • PALO ALTO, CALIFORNIA • 94304

March 19, 1975

Mr. R. W. Gutman
Director
United States General Accounting Office
Washington, D.C. 20548

Ref: Draft Report - "The California Four Cities Program"

Dear Mr. Gutman:

The draft report "Technology Transfer and Innovation in the Public Sector - The California Four Cities Program" has been reviewed and the following comments are offered for your consideration. In general, we found the report well written, covering all aspects of the program.

1. Local governments are not accustomed to sponsoring research and development, with its risk factors, to find solutions to a problem or need in the city. A way must be found to fund this research and development either at the State level or the Federal level. The alternative is to be able to convince a company that there is a large enough market waiting for a product that it would pay the company to finance development. There has been little effort to date to form such markets. Indeed, some city charters prohibit joint purchasing with other cities.

2. A large void exists in the knowledge of city personnel about new technologies and the possible application of these technologies to city problems. There is the need therefore for better dissemination of such information and in particular, the results and progress of such programs as this report is reviewing. Cities are slow to change the way things are done and they must be better informed if changes are to be made.

3. The recommendation that programs lend themselves to a cost/benefit analysis may be over-emphasized, since many programs which are needed (public safety, building code revisions for new materials, etc.) will not show a result.

Lockheed has enjoyed its role in this program and has gained considerable knowledge regarding the needs of cities and how they function. We agree with your report that the program has been beneficial and hope Congress will study the report and continue to provide the means for such programs to continue and expand.

W. J. Peterson
Department 52-24
Building 201

WJP:ls

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May 8, 1975

Mr. R. W. Gutmann, Director
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Gutmann:

SAI has reviewed your draft report "Technology Transfer and Innovation in the Public Sector - The California Four Cities Program." We are pleased to offer the following comments, not so much on the report--since we found it to be well done and an accurate representation of the program--but on what we have concluded from the program as a participating industry.

Our original participation in the Four Cities Program had three objectives: (1) to help solve city problems with technology; (2) to develop an internal company awareness of city government's approach to problem solving; and (3) to develop a broader business base and financial record in civil systems programs. I would like to address these individually.

SAI's presence in the City of Fresno has been beneficial to the city. Our resident advisor has been able to help on a number of projects. More important, he has helped key city administrators to understand the process and benefits of program management and planning. The results have come slower than we had expected, however. We believe that there are a number of reasons for that. The barriers to innovation in local government are more than informational -- they are strongly institutional. There is little incentive to innovation--success can seldom be rewarded, but failure can be broadly publicized--internally and externally. There is no equivalent to reward and development, or really even development, under city direction. This characteristic reliance on industry to provide new products is reflected in a generally passive reaction to the concept of a strong internally-generated technology utilization program. We feel that future programs on technology transfer and utilization should formalize the active participation of the cities involved beyond a policy role for the City Manager.

The second objective--that of building our own understanding of local government operations--is being achieved. The advisor has been broadly involved in city operations as an integral part

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Other SAI Offices Albuquerque, Ann Arbor, Arlington, Atlanta, Boston, Chicago, Huntsville, Los Angeles, McLean, Palo Alto, Santa Barbara Sunnyvale and Tucson

APPENDIX VIII

of the City Manager's staff. His full time involvement limits the short run use of this experience on other company activity, but the long range benefits to us are significant and valuable.

The third issue--that of expansion of our business activity in civil systems programs--has been distinctly disappointing. The Four Cities Program operates by identifying and matching city problems with possible solutions. In most cases, only partial solutions are available--a natural condition when looking at technology developed for different purposes (e.g., aerospace). Modification of technology to fit a city problem solution must be paid for, but city budgets (and often city policies) are not now sensitive to this need. That in fact is a basic justification for such federal funding as goes to RANN and other NSF projects. Cities tend to look to such grant programs (along with PTI activities) as the primary source of technology transfer activities. However, history shows that those funds have been strongly biased towards other than private industry, concentrating on university and non-profit agencies. It is my hope that as technology utilization becomes more integrated into city objectives, the role of industry will become more direct and more substantial.

SAI has been pleased and proud to be a part of the Four Cities Program (and now The California Innovation Group) and intends to remain active and involved in technology utilization by local government. Please feel that you can call on us at any time for further discussions of this most significant subject.

Sincerely,

J. R. Beyster
President

JRB/n

PRINCIPAL FEDERAL OFFICIALS RESPONSIBLE FOR THE ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
NATIONAL SCIENCE FOUNDATION		
DIRECTOR:		
H. Guyford Stever	Feb. 1972	Present
Raymond L. Bisplinghoff (acting)	Jan. 1972	Feb. 1972
William D. McElroy	July 1969	Jan. 1972
ASSISTANT DIRECTOR FOR RESEARCH APPLICATIONS:		
Alfred J. Eggers, Jr.	May 1971	Present
DIRECTOR, OFFICE OF INTERGOVERNMENTAL SCIENCE AND RESEARCH UTILIZATION:		
M. Frank Hersman	May 1970	Present
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION		
ADMINISTRATOR:		
James C. Fletcher	Apr. 1971	Present
ASSISTANT ADMINISTRATOR FOR INDUSTRY AFFAIRS AND TECHNOLOGY UTILIZATION:		
Edward Z. Gray	Apr. 1973	Present
DIRECTOR, TECHNOLOGY UTILIZATION OFFICE:		
Jeffrey T. Hamilton	July 1971	Present

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