REPORT TO THE CONGRESS

Means For Increasing The Use Of Defense Technology For Urgent Public Problems B-175132

Department of Defense,

Office of Management and Budget,
and Other Civil Agencies

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

DEC. 29, 1972

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

B-175132

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

This is our report on means for increasing the use of defense technology for urgent public problems. This report discusses activities of the Department of Defense, the Office of Management and Budget, and other Federal agencies.

Our review 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).

Copies of this report are being sent to the Director, Office of Management and Budget; the Director, Office of Science and Technology; the Secretary of Defense; and the heads of the other departments and agencies mentioned in the report.

Elmer B. Staats

Comptroller General
of the United States

Contents

ABBREVIATIONS

AEC	Atomic Energy Commission
DOD	Department of Defense
FAA	Federal Aviation Administration
GAO	General Accounting Office
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
NSF	National Science Foundation
OMB	Office of Management and Budget
OST	Office of Science and Technology

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

MEANS FOR INCREASING THE USE OF DEFENSE TECHNOLOGY FOR URGENT PUBLIC PROBLEMS
Department of Defense, Office of Management and Budget, and Other Agencies B-175132

D I G E S T

WHY THE REVIEW WAS MADE

The Congress and the President have expressed concern that greater application be made of the vast scientific and technological resources of the Federal Government--until now directed in large part to defense and space problems--to help solve massive sociological problems facing the United States.

The problem areas are familiar: transportation, law enforcement, environmental protection, education, housing, and urban development.

"Technology or a technological resource" may be defined as any

--hardware device,

--equipment or system,

--scientific know-how,

--engineering design or process,

--specialized laboratory or testing facility, or

--specially trained person.

The contribution which the Department of Defense (DOD) can make in this area becomes clear when it is realized that DOD spends about $8 billion a year in research and development--nearly half the Federal research and development budget--involving virtually every scientific and technical field.

The General Accounting Office (GAO) has sought to identify ways by which DOD and Federal civil agencies can share and put to use--more than is being done today--the Government's technological resources to solve critical problems facing the Nation.

Background

This sharing is called technology transfer. It means that technology developed for a particular purpose may be adapted and applied to fill a different need in another environment. Transfer methods can be called

--passive; that is, collecting, processing, and distributing technical documents and data on request of potential users or

--active; that is, personal liaison between developers of technology and its potential users frequently aided by third-party transfer agents. This method often involves sharing of laboratory or test facilities by one Federal agency with another.

The transfer process is complex, especially where the developer and potential user do not have similar technical backgrounds and where the commonality of problems is not obvious. (See p. 6.)

FINDINGS AND CONCLUSIONS

Examples of the merits of active methods of technology transfer are found in the Technology Utilization Program of the National Aeronautics and Space Administration (NASA) and also in experimental transfer efforts of the Department of the Navy.

--NASA's active approach led to the use of spacecraft technology in hospital operating room design.

--A Navy unit's active approach resulted in applying aircraft carrier fire-fighting technology to short takeoff and landing airports. (See ch. 3.)

Problem perspective

To a large extent, Federal civil agency attempts to solve urgent sociological problems involve State and local governments and undeveloped public markets which are too fragmented and ill defined to attract private enterprise. This contrasts with civilian applications of defense technology resulting from commercial spin-offs by DOD contractors in related fields, such as aircraft engines and fuels, radar, communications equipment, and computers. In these cases attractive civilian markets existed and were ripe for development. But such markets are not generally directed to solving urgent sociological problems. Through Federal civil agency leadership, however, markets for public technology products and services can be aggregated to attract private enterprise.

Constraints on DOD's transfer efforts

DOD's efforts are primarily passive because active efforts have been limited due to:

--The lack of policy guidance defining DOD's role in the transfer process, in contrast with the roles of NASA and the Atomic Energy Commission, which have legislation and formal policies encouraging transfers. (See p. 21.)

--The interpretation by some DOD officials that legislation prohibiting the expenditure of DOD funds for other than mission-related research inhibits an active role. This legislation, in GAO's view, was not intended to inhibit transfers when DOD is reimbursed by other agencies, and DOD can undertake an active role within existing statutory limitations. (See p. 23.)

--DOD's concern that the use of staff to assist civil agencies, even temporarily on a reimbursable basis, might lead to reductions in authorized ceilings. (See p. 25.)

Diverse transfer efforts by civil agencies

In the absence of a national policy and of guidelines which clearly define the responsibility of all agencies to encourage technology transfer, civil agencies differ widely in the extent that they seek and use DOD technology. Agencies with closely related technological interests (Coast Guard/Navy and Federal Aviation Administration/Air Force) use liaison staffs advantageously to identify and adapt DOD technology. Other agencies make little effort to seek potentially relevant DOD technology. (See ch. 5.)

Civil agencies should establish formal active procedures to take advantage of Federal technological resources particularly those of DOD. But without specific enabling

legislation (such as exist for the Federal Aviation Administration) or executive policy guidance--e.g., from the Office of Management and Budget (OMB)--most civil agencies, in GAO's opinion, will continue only sporadic efforts to use available Government technology.

One way to improve communications to facilitate problem-resource matching, especially between DOD and civil agencies, is to establish a central technology transfer consulting team. (See ch. 6.)

RECOMMENDATIONS

The Secretary of Defense should establish policy and procedures to encourage active transfer of DOD technology to civil agencies. (See p. 24 and app. I.)

The Director, OMB, should:

1. Establish, in consultation with the Office of Science and Technology, a Government-wide policy for technology transfer and issue guidelines for formal active transfer efforts. Guidelines should include exemptions from agency personnel ceilings of employees assigned to transfer activities and to tasks for which costs are to be reimbursed by other agencies. (See p. 36.)

2. Provide for a small technology transfer consulting team as a pilot effort to assist Federal agencies in matching technological resources with their needs in solving pressing national problems. Such a team might be established within an existing technology-oriented agency with no conflicting mission interests, such as the National Bureau of Standards or the National Science Foundation. (See p. 39.)

AGENCY ACTIONS AND UNRESOLVED ISSUES

GAO obtained comments on its report from agencies which either generate or need technology. Views were obtained also from OMB and the Office of Science and Technology. There was general agreement that active transfer methods were needed, although questions were raised as to the best way of achieving such transfers. (See p. 20.)

The Secretary of Defense has issued a policy statement endorsing nondefense work in DOD laboratories, subject to certain specified considerations. (See app. V.) The policy statement is an essential first step; guidelines to put the policy into effect still are needed. (See p. 24.)

OMB cited steps being taken to improve technology transfer. One experiment may involve the GAO recommendation for a technology transfer team. OMB said that it had long been the Government's policy to encourage technology transfer but did not agree to provide written guidelines for active transfer efforts by Federal agencies. (See app. VI.)

OMB believes that agencies operating under personnel ceilings have sufficient flexibility to share technology. DOD's plans to operate in 1973 without personnel ceilings should help DOD engage in more active transfer operations. GAO intends to follow up on the results of this action. Written policy and implementing guidelines from OMB and exemptions from civilian personnel ceilings would provide an important stimulus to action between all agencies seeking technology and those developing it.

MATTERS FOR CONSIDERATION BY THE CONGRESS

Defense-developed technology could be made more readily available to assist in solving sociological problems facing this country if the recommendations in this report were put into effect by OMB, DOD, and the civil agencies concerned.

CHAPTER 1

INTRODUCTION

Technology resulting from defense research and development represents a major national resource, part of which can be applied to help solve urgent sociological problems. An increase in such transfers would be an important step in achieving maximum return on the Nation's investment of billions of dollars. It could also help avoid unnecessary duplication in research, affect the national economy favorably, and strengthen the Nation's international trade balance.

In this report "technology transfer" is defined as the secondary application of technology developed for a particular mission or purpose to fill a different need in another environment. "Technology or a technological resource" may be defined as any hardware device; equipment or system; scientific knowledge, engineering design, or process; special laboratory or test facility; or specially trained person.

Our study considered the more significant interests expressed by the Congress and other organizations in the transfer process and assessed the means to enhance it. We were concerned with:

--Relative roles and responsibilities of the Department of Defense (DOD) and Federal civil agencies in the transfer process.

--Legislative and organizational factors which influence it.

--Assessment of the need for improved policies and procedures to enhance it.

Primary emphasis was directed to the Federal Government's role in the transfer process. The potentially significant role of the private sector, especially defense and aerospace contractors, was not examined in depth. *We believe the private sector's involvement in sociological applications of technology will develop when viable aggregate civilian markets are established through the leadership and support of the Federal Government in partnership with State and local governments.*

Two agencies within the Executive Office of the President are responsible for establishing Government-wide policy in research and development matters. The Office of Science and Technology (OST) is responsible for recommending coordinated Federal research policies and for evaluating research and development programs of Federal agencies. The Office of Management and Budget (OMB) not only assists the President in preparing and administering the Government's annual budget but also is responsible for developing coordinating mechanisms to implement Government activities, including scientific and technological programs.

We obtained comments on our report from DOD, OMB, OST, the Department of Commerce, the National Aeronautics and Space Administration (NASA), the Atomic Energy Commission (AEC), the National Science Foundation (NSF), and other Federal civil agencies mentioned in the report. Although we carefully considered all agencies' comments in completing this report, we believe it appropriate to include in the appendix the complete comments of only OMB and DOD since they are the agencies to which our recommendations are directed.

TECHNOLOGY TRANSFER PROCESS

The process involves knowledge that a technological advance has occurred, that it is significant and relevant in a different application, and that necessary adaptations can be made. The process occurs naturally between individuals or groups with similar professional disciplines working to solve common problems. However, where similar disciplines do not exist and the commonality of problems is not obvious, more formal transfer methods are required, which usually involve personal liaison between technology developers and potential users, possibly aided by third-party transfer agents.

Technology transfer is a complex process. The capability and resourcefulness of technology developers and potential users to recognize prospective applications of technology to areas other than originally intended is one of the most significant factors in successful technology transfer.

A partial listing of technology transfer mechanisms follows.

1. Scientific and other technical documents and publications.

2. Computerized data banks and services.

3. Professional, scientific, and technical society symposia.

4. Special technology conferences.

5. Intragovernmental technology committees.

6. National standards and military specifications committees.

7. Technology liaison staffs.

8. Interagency joint ventures.

9. Informal personal contacts.

10. Interagency sharing of Federal laboratories and test facilities.

11. Transfers from one agency to another of trained personnel and/or laboratory and test facilities.

12. Technology transfer agents (problem-resource counselors).

13. Small Business Administration technology utilization officers.

14. State technical services programs.

15. The Extension Service, Department of Agriculture.

The various mechanisms can be characterized as either passive or active.

Passive methods usually involve collecting, screening, indexing, storing, and disseminating scientific and technical information upon request of a potential user. The effectiveness of these methods depends upon such factors as the requester's ability to define the technology sought; the procedures used to search and identify requested information; the format in which the information is furnished to the requester; and the ability of the potential user to assimilate the knowledge, evaluate the relevance, and adapt the technology.

Active methods usually involve certain elements of passive methods supplemented by personal liaison between technology developers and potential users. This interplay helps define the user agency problems and identify existing relevant technology. An interdisciplinary third-party transfer agent team often bridges the possible communication gap between technology developers and potential users and helps with the transfer. The team would help to optimize the match between users' needs and resource potential.

CHAPTER 2

PROBLEM PERSPECTIVE

For many years the question of obtaining a better return on the investment in Federal research and development has been a topic of interest in numerous congressional hearings and the subject of many congressional committee and advisory group reports. Both the Congress and the President have expressed concern over the insufficient use of Federal technology.

RELEVANCE OF DOD TECHNOLOGY TO NONDEFENSE APPLICATIONS

DOD sponsors research and development in virtually every scientific and technical discipline. In fiscal year 1972 defense appropriations for research and development amounted to about $8 billion, an amount equal to that expended by all other Federal agencies. Approximately $1.5 billion of the DOD expenditures involves research and advanced technology in areas considered applicable to nondefense needs.

Applications of defense technology to the civilian sector are well known. In electronics, defense research has helped develop radar, communications equipment, and computers. The use of satellites for communication, navigation, mapping, and weather observations grew out of defense-sponsored research. Progress in commercial aviation is directly linked to defense leadership in developing new engines, fuels, and inertial navigation systems. Medical contributions include a potential vaccine for meningitis and the use of the laser in distended eye retina surgery. Infrared sensor technology has been adapted for detecting fires in mines and forests.

Most of these applications of defense technology resulted from spin-offs by the private sector, primarily DOD industrial contractors that were aware of the technology and the market potential and motivated by profit. In such an environment, industry plays a significant role in technology transfer.

To a large extent the potential markets for technology which can be applied to solving urgent sociological problems

have not developed sufficiently to attract private industry and investment capital. Generally, defense and aerospace contractors have been unable to deal effectively with these ill-defined and fragmented markets and the many local jurisdictional and political barriers. Therefore it has become necessary for the Federal Government to establish new priorities, as well as additional means, to accelerate the solution of domestic problems through creating new civil agencies.

CHANGING ROLE OF DOD AND EMERGING FEDERAL CIVIL AGENCY MISSIONS

Following World War II, the impact of science and technology as a major factor in winning the war invoked a national commitment to maintain this leadership for defense preparedness as well as to maintain a strong economy. The DOD-industrial partnership provided the major institutional means for this purpose, except for the AEC-industrial partnership in atomic energy.

Until NSF was established in 1950, the Office of Naval Research, the Air Force Office of Scientific Research, the Army Research Office, and AEC sponsored most of the Nation's basic research. Also, until NASA was formed in 1958, DOD sponsored most of the rocket development, satellite programs, and other aerospace research and technology. Some basic research formerly sponsored by DOD has now been transferred to NSF, and NASA has inherited essentially all the nonmilitary aerospace programs beginning with the transfer from DOD of selected Redstone Arsenal facilities and the Jet Propulsion Laboratory.

Major defense expenditures for the Vietnam War and the creation of new Federal civil agencies to meet urgent national problems--such as transportation, law enforcement and crime prevention, environmental protection and pollution control, health and education, and housing and urban development--have had a profound effect on DOD's national leadership role in science and technology. Budgetary restrictions and the unpopularity of military involvement in nondefense activities have imposed strong pressures on DOD to confine its activities strictly to the defense mission.

The mission character and functional roles of most Federal civil agencies differ significantly from those of DOD, AEC, and NASA. These three agencies have well-defined, cohesive missions with clear legislative and budget authority to plan, manage, and implement essential programs within their missions. They also have administrative machinery and authority for using resources of contractors in the private sector. Their dependence on other agencies is minimal. DOD and NASA, in particular, also provide markets for the technology they generate.

In contrast, most of the missions of Federal civil agencies concern aggregations of nationwide local problems with varying degrees of commonality and diversity. In many cases the ultimate success and implementation of their program responsibilities are contingent on acceptance and cooperation from State and local governments. The Federal agency role, therefore, is one of providing national leadership and coordination.

Political, sociological, jurisdictional, and economic factors greatly impede the acceptance of technological innovations by the ultimate users. Some agencies have the administrative machinery and authority to contract with the private sector for outside support. Others have been restricted largely to operating through grants to State and local government agencies, nonprofit institutes, foundations, and educational institutions. However, it is generally conceded that State and local governments do not have resources to adequately support and manage domestic problem-oriented research and development projects; thus to a large extent significant direct participation by private industry is precluded.

The primary role of Federal civil agencies in technological leadership, therefore, involves identifying problems and potential solutions that have nationwide commonality, adapting existing technology or sponsoring of appropriate research, demonstrating the feasibility of technological improvements, establishing national standards, and removing barriers to acceptance at State and local levels.

Applying defense and aerospace industry resources to solving domestic problems is largely contingent upon Federal Government leadership. As Federal civil agencies establish the mechanisms necessary to take advantage of existing DOD

technology, nondefense markets should evolve and the conversion could have a favorable impact on employment, the domestic economy, and the international trade balance.

CHAPTER 3

ADVANTAGES OF ACTIVE TECHNOLOGY TRANSFER METHODS

Active transfer methods involving personal interplay between technology developers and potential users, assisted by third-party transfer agents, can enhance and expedite the application of defense technology to sociological problems. Certain aspects of the NASA Technology Utilization Program and pilot transfer efforts of the Naval Weapons Center at China Lake, California, have demonstrated the merits of active methods. Passive efforts need to be supplemented by active methods to maximize the secondary use of DOD technology.

PASSIVE TRANSFER METHODS

Technical reports are DOD's primary means of recording the progress and results of defense research and development. These reports are available, within the limits of national security and administrative restrictions, to other Federal agencies and Government contractors and grantees by the Defense Documentation Center. Unrestricted reports are available to the general public through the National Technical Information Service of the Department of Commerce. Upon request, these organizations will search information banks for technical reports which may satisfy the user's needs.

NASA makes technical reports available through its Scientific and Technical Information Facility, as well as the National Technical Information Service, Department of Commerce. In addition, as part of its Technology Utilization Program, NASA has expanded upon the traditional dissemination of technical reports in an attempt to make passive mechanisms more useful to secondary users. These efforts include (1) publishing special documents which describe technology that may have secondary application and (2) operating several regional information dissemination centers with access to interconnecting computers. The centers also assist the users in defining the subject areas to be searched, designing literature search strategies tailored to the problem at hand, screening computerized search results to eliminate irrelevant information, and interpreting the identified technical information in terms of relevance to the user's needs.

AEC also supports a comprehensive program for collecting, documenting, and disseminating nuclear technology. Within the restrictions of national security, reports derived from AEC's research programs are available to other Federal agencies and the general public through the National Technical Information Service and AEC's Office of Information Services.

DOD, NASA, AEC, and other Government agencies also sponsor information analysis centers which gather information in specialized fields of science and technology. The centers generally evaluate and provide summaries of the data in formats useful to requesting organizations. Although the DOD centers have not been available to the general public in the past, procedures are being formulated to permit this on a limited basis.

Limitations

Disseminating scientific and technical information alone, particularly in the form of technical reports, even with the aid of a computerized search service, is not generally adequate for transferring technology. Identifying relevant technology through publications is only one facet of the transfer process.

Passive information dissemination mechanisms concern primarily announcing the availability of technical information and providing the information upon request. The actual transfer depends upon the user's ability to recognize, understand, and adapt relevant technology in the publications and reports. This is particularly difficult where similar disciplines are not shared with the technology developers.

Technical reports are limited in the transfer process because:

--They are prepared primarily to document the results of research and development projects and do not address potential secondary applications.

--Technological developments frequently are not described in a manner that can be readily understood and related to a different context or application by potential users.

--The sheer volume of reports and variety of categories make it difficult to identify pertinent technology.

The limitations of passive dissemination efforts have been widely recognized throughout the Government. For example, a Department of Commerce report dated November 17, 1969, prepared for various Senate committees, cited the ineffectiveness of technical reports as transfer mechanisms. The report stated:

> "That DOD, AEC, and NASA have developed many new devices and (problem) solutions is beyond question. *** the publication and dissemination of technical reports relative to these developments are essential but it does not go far enough. There is a very low probability that a report will arrive at the desk of someone who can match that particular problem."

Also DOD has been concerned about the benefits which can be derived from technical documents. In a memorandum to the Director of Defense Research and Engineering, dated August 6, 1971, the Assistant Secretary of the Navy (Research and Development) stated that written reports which described technological accomplishments for use by the civilian economy had limited utility because the technical community was very compartmentalized by disciplines.

The limitations of technical reports as communication media of new technology are somewhat overcome by procedures specifically designed to report technological advances that may have secondary application in other fields. NASA's special technical publications are designed for this purpose, and the Air Force recently initiated a program with the Small Business Administration to disseminate to small business abstracts of invention disclosures reported by its contractors. Notwithstanding the advantages of these procedures over regular technical reports, they generally must be supplemented by active efforts.

MERITS OF ACTIVE TRANSFER METHODS

NASA and the Naval Weapons Center successfully use active transfer techniques, including third-party transfer agents, to identify problems in the public sector to which existing aerospace and defense technology may apply.

A transfer agent helps technology users and developers, as follows:

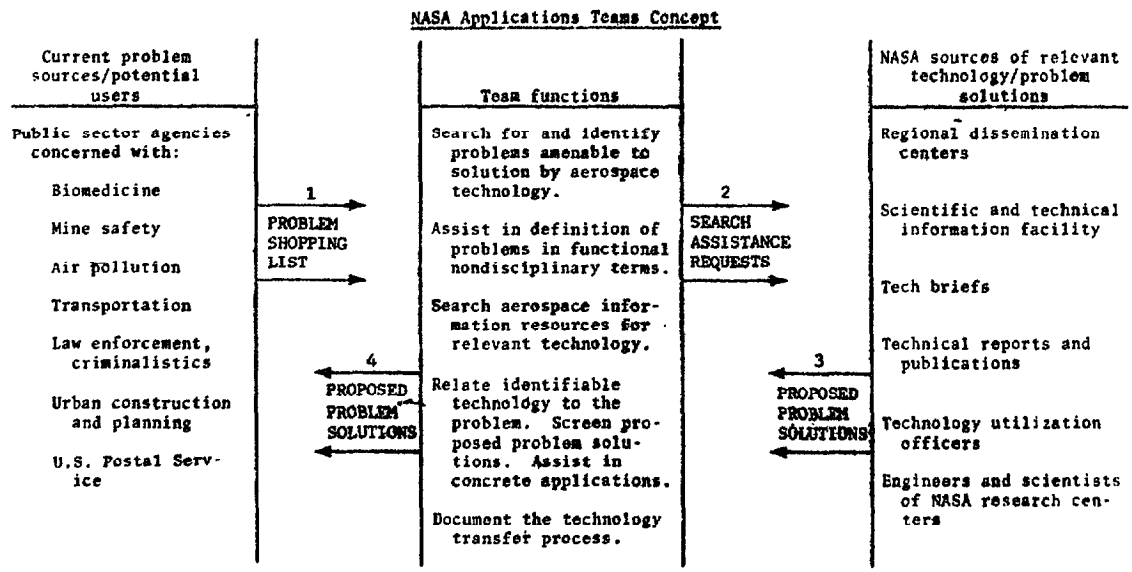
Technology user	Technology developer
Identify needs or opportunities for improved technology.	Assess resource potential for secondary applications.
Refine problem definition and translate into technological terms.	Search for and identify potential users.
Identify relevant technological resources.	Interpret users' needs, requirements, etc.
Solicit responsive proposals from developers.	Critique proposals prepared by the developer.
Select best alternative.	Maintain current knowledge of developers' technological innovations and expertise.

Active aspects of NASA's Technology Utilization Program

Recognizing the need for active, as well as passive, technology transfer methods, NASA initiated an applications team concept in 1965 as part of its Technology Utilization Program. These teams serve as liaisons between the technology developer and the potential user by identifying problems in the public sector and possible solutions from available NASA technology. Teams are active in such areas as biomedicine, law enforcement, water and air pollution, transportation, and urban construction and planning.

Transfer methodology

The problem-solving approach of the teams (1) focuses multidisciplinary expertise on technological problems, (2) provides access to NASA's scientific and engineering resources, and (3) facilitates the secondary use of existing technology. In many cases the teams are concerned with combinations of technological advances to achieve generic improvements in broad areas, such as urban development and law enforcement. The methodology involves close contact with civil agencies to identify and define problems. The civil agency is primarily responsible for completing the actual transfer; however, the teams help arrange test experiments or adaptations, where possible. The following chart illustrates the basic methodology of the applications teams.



Program accomplishments

The teams have assisted in transferring much aerospace technology to the public sector. Examples include:

1. Advances in design and construction of contamination-free rooms used in fabrication of spacecraft components are being used in designing hospital operating rooms.

2. A space helmet with sponge electrodes, originally developed by NASA to obtain electroencephalographic

tracings from astronauts and test pilots under stress, is being adapted to detect hearing defects in infants.

3. A device developed to measure gas and vapor pressure is being tested for implantation in paraplegic patients to control urination.

4. Work on the astronaut life-support system for Apollo lunar excursions may help solve the smoke inhalation problem faced by firemen.

5. Instrumentation developed for performance testing of eye, hand, and foot coordination of astronauts subjected to contaminated air is being evaluated for testing the effect of air pollution on automobile drivers.

6. A lightweight, compact aerosol particle analyzer developed for the Apollo spacecraft has been identified as a means for measuring the level of coal dust concentrations in mining operations.

NASA, which considers the teams program experimental and only one means of expediting the transfer of available aerospace technology to domestic problems, believes the team concept has gained widespread acceptance. NASA also feels that the teams have clearly demonstrated that traditional communication barriers to technology transfer can be overcome through clearly focused and directed efforts to solve some of the public sociological problems.

Navy active transfer efforts

In October 1970 the Naval Weapons Center began a pilot program to transfer Navy technology to Federal civil agencies using in-house staff and a third-party transfer agent under contract to the Center. The program operated under the premise that (1) the primary mission of the Center would not be compromised and (2) civil agencies would reimburse the costs.

Transfer methodology

This transfer agent educated Center personnel on current technological needs of civil agencies, demonstrated to civil agencies the relevant Navy technology, and established

communication links between the technology developers and potential users. Center personnel suggested technology likely to solve civil agency problems identified by the transfer agent. Upon request of a civil agency, the Center prepared a proposal to perform the necessary adaptations. They were made only if the civil agency funded them.

Program accomplishments

This program, although experimental, has shown a high potential for success. Examples of Navy-developed technology which have interested civil agencies are:

Technology	Potential application
Shock wave measurement technique	Inkless fingerprinter
Aircraft carrier fire-fighting technique	Short takeoff and landing airports
Voice scrambler	Law enforcement communications
Luminescent chemicals	Ground traffic safety

The Federal Aviation Administration (FAA) plans to use the aircraft carrier fire-fighting technology in developing effective and economical fire-fighting systems for elevated commercial short takeoff and landing airports and for jet transport fuel system fire protection. The National Highway Traffic Safety Administration plans to provide funds for adapting luminescent chemical technology to emergency highway flares. The laboratory originally developed the technology as an aid to personnel rescue operations at sea and as a target marker.

The contract effort for the Naval Weapons Center was completed in January 1972, and in-house personnel and an individual assigned to NSF assumed the contractor's function. In addition, the Center has formed a consortium of defense laboratories to offer a broader technology base for civil agency problems.

In February 1971 the Naval Ordnance Laboratory in White Oak, Maryland, established a technology transfer office, similar to that of the Naval Weapons Center, to seek civil agency problems which could be solved through applying Laboratory-developed technology. The office is responsible

for (1) establishing liaison with Federal civil agencies, (2) identifying civil agency problems, (3) assessing Laboratory technologies as potential solutions, and (4) coordinating interaction between civil agencies and Laboratory personnel to facilitate transfers. As of July 1971 these efforts had identified several areas which appeared relevant to civil agency problems. Three agencies had provided funds to the Laboratory for feasibility tests and studies of pertinent technologies.

AGENCY COMMENTS

The civil agencies that are potential users of DOD technology concurred in the need for active transfer efforts or expressed preference for active over passive arrangements. Those agencies that may be considered major technology developers (DOD, AEC, and NASA) also indicated a preference for active transfer efforts although they raised questions concerning the best transfer mechanisms.

CHAPTER 4

FACTORS LIMITING ACTIVE TRANSFER EFFORTS BY DOD

DOD's positive actions to enhance the transfer process have been limited by the absence of DOD policy guidance; the interpretation by some DOD officials of legislative restrictions on the expenditures of research and development funds for other than defense; and DOD's concern that use of staff to assist civil agencies, even temporarily on a reimbursable basis, might lead to reductions in authorized civilian personnel ceilings.

ABSENCE OF POLICY GUIDANCE

DOD does not have specific policy guidance encouraging or fostering the secondary application of defense technology to urgent national sociological problems. In contrast, other agencies (also major sponsors of research and development) such as NASA and AEC, have enabling legislation and implementing policies supporting positive action to transfer technology.

DOD is the Government's largest sponsor of research and development. However, with the exception of a few pilot programs, its transfer efforts are primarily passive.

The DOD Scientific and Technical Information Program is an integral part of its research, development, test, and evaluation mission. The basic purposes of the program are to insure the timely, effective, and efficient conduct of the defense mission and to eliminate duplication of effort and resources within DOD through the continuous and ready exchange of information. The results of DOD research and development efforts, with certain exceptions, are also made available to civil agencies and to the general public. We categorize this program as passive. The limitations of a passive technology transfer process are discussed in greater depth in chapter 3.

In April 1969 the Secretary of Defense stated that DOD could play a significant role in solving the Nation's urban problems. At that time he established the Domestic Action Council and charged it with the responsibility for discovering and implementing ways to make a greater contribution to

solving public problems. DOD then established several areas with which Domestic Action Programs should be concerned, including equal opportunity, community relations, and transferring technical knowledge.

According to the Executive Secretary of the Council, the main thrust of the programs has been to enhance community relations near military installations. The Council has been encouraged to seek better methods to apply defense technological advances more rapidly in the civilian economy, but no implementing policies have been recommended because of uncertainty about DOD's role in such activities.

Contrast with NASA and AEC

The National Aeronautics and Space Act of 1958 (42 U.S.C. 2451) states that it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind. The NASA legislation also provides for the widest practicable and appropriate dissemination of information concerning its activities and their results.

NASA's implementation of the act resulted in the establishment of the Technology Utilization Program in 1962 which involves both passive and active transfer methods. (See p. 16.)

The Atomic Energy Act of 1954 (42 U.S.C. 2161) authorizes AEC to provide for programs directed toward (1) disseminating unclassified scientific and technical information and (2) developing and using atomic energy for peaceful purposes. AEC officials consider that AEC's *primary* mission includes transferring nuclear technology to the public and private sectors for the Nation's welfare.

Consistent with this authority, AEC has encouraged the transfer of unclassified nuclear technology to individuals and organizations for both nuclear and nonnuclear purposes. AEC sponsors various efforts to insure that knowledge of unclassified technology developed under AEC sponsorship is disseminated to the fullest possible extent for the public benefit and that technical assistance is made available when necessary to accomplish the transfer.

In addition, the Atomic Energy Act authorizes AEC laboratories to perform work for other agencies. Amendments to the act in 1967 and 1971 extended this authority to include nonnuclear work for others in the fields of energy, public health and safety, and environmental protection. Therefore formal policy guidelines have been issued to all AEC laboratories and modest active efforts have been undertaken to identify civil agency needs and to submit proposals for interagency research and development. As of November 1971, there were a number of interagency agreements and at least one AEC laboratory had about 15 percent of its support from other Government agencies.

Restriction on use of DOD funds for nondefense research

Recent legislation precluding the expenditure of defense research and development funds for other than mission-related projects has tended to raise concern within DOD as to the role it should pursue in technology transfer for civil agency use.

The Defense Procurement Authorization Act (Public Law 91-121) limited DOD's use of fiscal year 1970 funds to those research projects which had a "direct and apparent relationship to a specific military function or operation." To comply, the military services canceled numerous basic research projects which did not appear relevant to the defense mission. The 1971 Department of Defense Procurement and Research Authorization Act (Public Law 91-441) modified the previous legislation to limit the use of such funds to those research projects or studies which have "in the opinion of the Secretary of Defense, a potential relationship to a military function or operation."

Several DOD officials have advised us that, because of this legislation, there is a reluctance to initiate any active efforts or to enunciate formal policy guidance encouraging DOD centers to facilitate transfers to the civil sector. On the other hand, some DOD officials do not consider active technology transfer efforts to be in conflict with this legislation, as long as the efforts do not interfere with primary mission responsibilities and are performed on a cost-reimbursable basis, as in the case of the pilot program at the Naval Weapons Center. (See p. 18.) Also the Air Force

Systems Command, on December 9, 1971, established policy guidance for Air Force laboratories to assist civil agencies along these lines.

The legislative histories of the statutes restricting DOD research to military projects do not indicate any congressional intent to limit the *transfer* of DOD technology to the civil sector, but rather to confine DOD *research expenditures* to areas of military relevancy. We therefore believe that, although legislative clarification delineating DOD's role might be desirable, it is appropriate within existing statutory limitations for DOD to encourage active transfer to make its technological resources available to civil agencies to an extent that does not interfere with the defense mission.

Recommendation to DOD

We recommend that the Secretary of Defense establish policy and procedures to encourage the greater application of existing defense technology by DOD's research and development centers to civil agency problems through active transfer processes. Some suggestions for DOD's use in preparing its policy and procedures are listed in appendix I.

Agency comments

DOD told us in its letter dated May 18, 1972, that it supported our recommendation. (See app. IV.) Subsequently, on June 21, 1972, the Deputy Secretary of Defense issued a memorandum endorsing the concept of sharing defense technological resources with civil agencies, within certain limitations, and encouraging the military services to participate. (See app. V.) We believe that this statement of policy is an important step forward and, if followed by implementing actions to insure compliance, should result in increasing the use of defense technology in solving civil problems.

CIVILIAN PERSONNEL CEILINGS

According to DOD officials, limitations on civilian personnel employment ceilings and, in particular, the *threat* of reductions in authorized ceilings from one year to the next constituted a major blockage inhibiting research and development centers from assigning scientists and engineers to nondefense interagency support.

The present system of administrative personnel ceilings, according to OMB, is as follows:

> "Under the existing system, the Office of Management and Budget establishes employment ceilings on behalf of the President only at the departmental or independent agency level. Internal personnel allocation among an agency's various programs, activities and installations is determined (or delegated) by the agency head. Such allocation is desirable to assure that agency management can adjust to changing functions and program priorities by intra-agency reallocation of staffing patterns. In addition, ceilings are established only for June 30 of each year for full-time permanent and total agency employment ***."

DOD's concern seems to be that, when the end of the year count is made, personnel assigned even on a temporary and reimbursable basis to nondefense work may be considered nonessential and excluded from ceilings projected for the next year. In establishing the ceilings no distinction is made in professional level, type, or job classification. Hence a laboratory director or project manager who permits scientists and engineers to participate in nondefense work might lose billets. Although at any one time the total number of defense employees assigned to nondefense work is a negligible percentage of the total number of civilian employees, the impact of this problem (or threat) at the laboratory director or project leader level requires attention.

Earlier attempts to resolve the problem

This problem was recognized by the Federal Council for Science and Technology in a policy statement dated March 1, 1972, entitled "Policy for Expanded Interagency Cooperation

in Use of Federal Laboratories." The statement included the following recommendation.

> "In order to insure that the agency providing R&D [research and development] support can respond promptly to urgent needs, it is recommended that OMB establish a special personnel ceiling reserve which could be made available to requesting agencies on a quick response basis to cover the manpower needed to undertake such work. The allocation from the reserve should be of a temporary nature to revert back to OMB upon completion of the work, or if the work is of a continuing nature, when the performing agency can have an opportunity to include the requirement in its next Congressional budget request."

The Council also proposed that:

> "*** the additional in-house manpower required to assist other agencies with such research support not be charged against the agency's regular manpower ceiling. Normal interagency work conducted as part of the agency's basic charter, however, would continue to be included in regular manpower ceilings."

The Deputy Secretary of Defense endorsed the spirit and intent of the Council's policy statement in his June 21, 1972, memorandum referred to on page 24. He also directed the Assistant Secretary of Defense (Comptroller) to explore with OMB "means for providing relief from any imposed manpower constraints to the extent of the DOD participation in non-defense work."

The Council asked OMB to endorse the March 1, 1972, policy statement. On June 23, 1972, OMB informed the Council Chairman that the policy statement was generally consistent with the administration's approach on use of resources and research and development capabilities, except for the Council's position on personnel ceilings. OMB believes that the existing personnel ceiling system is sufficiently flexible to take care of most of the Council's concerns.

In a report to the Congress entitled "Impact of Employment Ceilings on Management of Civilian Personnel" (B-165959, Apr. 30, 1971), we concluded that "Personnel ceilings or hiring limitations do not provide the most effective management control over civilian personnel" and proposed to OMB that "departments and agencies be permitted to accomplish their programs without restrictions on numbers of personnel, being limited only by the availability of funds."

On December 26, 1970, OMB agreed to eliminate DOD's administrative ceilings on civilian employment for a trial period of 1 year. It was our understanding that the test would cover fiscal year 1972. The test was halted, however, when, as a result of budget decisions, the Secretary of Defense reinstated civilian employment ceilings on January 6, 1972. In a letter to the Director, OMB, dated May 10, 1972, we suggested that the test be resumed in DOD and in selected civil agencies to determine whether this would provide the agencies with more flexible and effective means of managing total manpower resources. In response, OMB said that, because of high and continuing Presidential and congressional interest in controlling the number of persons on the Federal payroll, OMB saw no viable alternative to the present system of controls.

In view of our previous study of this problem, we did not attempt to determine whether personnel ceilings may have been reduced because of temporary assignment of DOD staff to nondefense work. We believe, however, that the continuing threat of ceiling adjustments is a significant problem inhibiting interagency sharing of technological resources. Comments from other agencies reinforced this view. NSF, for example, stated that "the [GAO] recommendation to exempt the DOD manpower assigned to urgent National civilian projects from the normal personnel ceilings of the performing agencies is a critical requirement for a successful DOD technology transfer program."

Neither NASA nor AEC has the same personnel ceiling constraints as DOD has on technology transfer efforts. NASA's legislation explicitly supports a Technology Utilization Program which is provided for as a budget line item. AEC's charter includes a direct authorization for technology leadership and for support of other agencies and the private sector in energy, safety, and environmental science. Also

AEC's laboratories are for the most part federally funded contract research centers subject to AEC program and budget controls, but they are not subject to personnel ceilings imposed by OMB.

DOD action

In August 1972 the Assistant Secretary of Defense (Comptroller) rescinded the ceilings imposed by the Secretary of Defense in January 1972 and relieved DOD's services and agencies of ceilings on civilian employment for fiscal year 1973. This action has reinstated the trial elimination of DOD employment ceilings that had been halted in January 1972.

Conclusion

Although DOD will operate without ceilings in 1973, there is, of course, no assurance that the trial will be extended beyond 1973. But we see no need to make any recommendation on the subject pending evaluation of the results of the trial. We plan, however, to follow closely the impact, if any, of the trial on the implementation of DOD's recently issued policy on sharing defense technological resources with civil agencies.

CHAPTER 5

DIVERSE POLICIES AND PRACTICES OF CIVIL AGENCIES IN THE TECHNOLOGY TRANSFER PROCESS

The transfer process involves a two-way partnership. Successful transfers require DOD to encourage transfers and help adapt its technology to civil agency requirements and the civil agencies to seek out and use whatever technology seems adaptable to their missions.

VARIED TRANSFER EFFORTS BY CIVIL AGENCIES

Civil agencies with technology interests similar to those of DOD organizations (Federal Aviation Administration/Air Force and Coast Guard/Navy) have been relatively successful in adapting DOD technology where common disciplines and problems are shared. The transfers occur usually through well-defined liaison.

Conversely, civil agencies which have less obvious commonality with DOD's disciplines and problems and for which applications of DOD technology are not self-evident, generally have not established formal policy guidance or active liaison to seek technology transfers.

Urban Mass Transportation Administration, Department of Transportation

This agency is responsible for undertaking research, development, and demonstration projects to assist in meeting urban transportation needs. It may establish working agreements with other Federal agencies or perform projects independently. In commenting on our report, the agency referred to a project being carried out for it, through an interagency agreement, by the Navy's Underwater Systems Center.

Agency officials stated that some defense technology could probably be applied to agency mission requirements but that active attempts to seek and use this resource were not made. For example, even the bibliographic and technical report dissemination services of the Defense Documentation Center and the National Technical Information Service are

generally not used because technical staff and funds are too limited to permit efforts to identify and apply relevant technology. Consequently, except for in-house research programs, the agency relies primarily on the initiative of private companies which are also defense contractors to propose and provide the technology necessary to accomplish mission objectives.

Environmental Protection Agency

The Environmental Protection Agency sponsors research and development programs to determine the cause and effect relationships of environmental pollutants and to develop solutions for pollution abatement and control problems.

Agency officials stated that, because of a lack of resources, they had not established policies or procedures for systematically seeking out existing defense technology before beginning new research and development projects. Agency personnel who know about related defense research work or expertise informally seek available capabilities. We were advised, however, that most DOD technology was not directly relevant to the agency's requirements and was often too complex and costly to adopt.

However, the third-party transfer agent working under contract with the Naval Weapons Center identified several potential applications of DOD technology to the agency's needs. (See ch. 3.) These include (1) polarographs for monitoring water pollution, (2) the millimeter wave diagnostic technique for air pollution monitoring, (3) tunable dye lasers for stratospheric monitoring, and (4) the cyclotron activation technique for trace metal analysis.

National Oceanic and Atmospheric Administration, Department of Commerce

The primary missions of this agency are to (1) develop and conserve marine resources, (2) develop and operate more effective environmental monitoring and prediction systems, and (3) obtain greater knowledge of oceanic and atmospheric phenomena.

Many defense-developed technologies--such as hydrology, direct and remote sensing techniques, hydroacoustics, oceanographic instrumentation, short-range sonar, and submersibles and buoys--are related to the needs of the agency. For

certain research the agency has used Navy-developed technology on hulls, moorings, and anchorages.

According to officials, they tried to identify available technology through personal contacts at seminars, symposia, and interagency meetings and through literature searches of the technical information banks of the Defense Documentation Center and the National Technical Information Service. More formal transfer mechanisms were needed, they believed, when application was less obvious. This would, however, require more staff and funds.

Bureau of Mines, Department of the Interior

The Bureau conducts major research on metallurgy, health, and safety and administers regulatory programs necessary to stimulate the private sector to produce minerals and fuels needed by the Nation. Health and safety research is directed toward developing procedures and devices to avoid, detect, or control those aspects of mining and the working environment which involve potential hazards.

In the past the Bureau has relied on a number of defense laboratories for research and development related to mines, health, and safety. Recent transfer efforts by the Naval Ordnance Laboratory, Silver Spring, Maryland, have identified technology of potential use to the Bureau.

Bureau officials stated that formal policies and procedures had not been established for seeking and using technology developed by other Federal agencies. Available resources are identified through contacts by Bureau personnel with laboratories of other Government agencies. The Bureau encourages its personnel to use data banks of the Smithsonian Institution's Science Information Exchange and the Defense Documentation Center before starting new research.

Law Enforcement Assistance Administration, Department of Justice

This agency was established to assist State and local governments in improving law enforcement and criminal justice systems and in reducing crime. Through the National Institute of Law Enforcement and Criminal Justice, it

sponsors and conducts research, development, testing, and evaluation of systems and equipment to improve law enforcement.

The Institute has entered into agreements with some defense laboratories to develop new technologies or convert existing technologies for use in criminal justice. For example, it has awarded grants to an Army laboratory to determine the feasibility of detecting processed heroin by either mass spectrometry or plasma chromatography.

The Institute has identified a substantial amount of defense technology and resources as relevant to its needs. There are no formal policies and procedures, however, for seeking out defense technology before beginning new research programs. Available resources are sought informally at the discretion and initiative of Institute personnel who know of related research work.

National Highway Traffic Safety Administration, Department of Transportation

This agency is responsible for conducting research programs on motor vehicle and traffic safety. It has a number of joint research and development projects with other agencies, including the Air Force and Navy. Also it is using special facilities of certain Air Force laboratories to test new concepts for automotive safety devices.

A combination of formal and informal procedures is used to identify available technology, including the Automatic Distribution of Documents program of the Defense Documentation Center. Literature searches are made at the National Technical Information Service before starting new research projects; according to agency officials, however, this procedure is tedious and relatively unproductive. Consequently the agency relies primarily on knowledge of its technical staff to identify existing technology.

United States Coast Guard, Department of Transportation

The Coast Guard has established an Office of Research and Development whose primary mission is to provide research,

development, test, and evaluation support for the agen s operational program managers under Department managemen guidelines. The Coast Guard develops techniques, equipment, and systems in support of aids to maritime navigation; ice-breaking facilities; search and rescue requirements; and marine law enforcement for promoting safety of life and property on, under, and over the high seas and waters of the United States. Included in these endeavors are ways of controlling pollution by oil and other hazardous substantances in the coastal and offshore environment, as well as the development of all-weather vessel traffic and harbor navigation system.

The Coast Guard has used Navy-developed technology relating to advanced propulsion systems, engine noise suppression, and ship hull design. Navy- and NASA-developed remote sensing technology has been applied in the Coast Guard's helicopter search and rescue program and in oil slick detection and measurement. Also the Coast Guard has entered into a number of interagency agreements with Navy laboratories for joint research and development in oil pollution control.

Coast Guard use of Navy technology is natural because of similar interests and because many Coast Guard research and development personnel worked for DOD or NASA. Informally, Coast Guard personnel often contact their counterparts in DOD and NASA to learn of relevant projects before starting any new research and development. More formally, Coast Guard personnel use the services of the Defense Documentation Center, the National Technical Information Service, and the Science Information Exchange to get information on past and current DOD research projects.

Federal Aviation Administration

FAA is responsible for (1) regulating air commerce to promote safety and development, (2) achieving the efficient use of the U.S. airspace, (3) developing and operating a common system of air traffic control and air navigation for civilian and military aircraft, and (4) promoting the development of a national system of airports.

The Federal Aviation Act directs the Administrators of FAA and NASA and the Secretary of Defense to arrange for the timely exchange of information on policies, programs, and

requirements of common interest. In addition, the Act specifically provides for military participation in FAA's research and development.

This mandate has resulted in procedures designed to insure that the technology of DOD and NASA is incorporated in FAA's programs where applicable. For example, FAA's Systems Research and Development Service routinely searches DOD's and NASA's technology data banks for information which may provide solutions to specific problems. Also these agencies have established several joint committees for coordinating research programs in specific technological areas, such as radar and navigation. FAA and DOD have initiated other management actions to insure a continual exchange of technical information, including the assignment to FAA of military liaison personnel responsible for identifying defense laboratory research projects which may be applicable to FAA's needs.

According to FAA officials, most of the air traffic control technology used in the Nation's civil aviation system orginated in DOD, particularly radar, radar beacon, and distance-measuring equipment. There are many joint venture agreements among FAA, DOD, and NASA to conduct research in technological areas of common interest to FAA. These include:

--Clear air turbulence detection.
--An automated ground-based fog dispersal system.
--Aircraft engine noise and pollution abatement.
--Fire retardant material for aircraft interiors.
--Airport runway pavement improvements.

OTHER VIEWPOINTS OF CIVIL AGENCY USE OF EXISTING TECHNOLOGY

Various studies and reports identified, with few exceptions, the lack of action by civil agencies to seek available technology as a problem which impeded technology transfer. These observations coincide to a great extent with answers to our inquiries at selected civil agencies.

One report noted that:

> "Very few agencies had a specific policy to urge their personnel or their contractors to make searches of the existing scientific and technical literature and to take other appropriate steps to identify and use relevant existing technology prior to undertaking new research and development efforts."[1]

These views were also shared by the technology transfer agents involved in the Naval Weapons Center program to identify existing Navy technology for use by various civil agencies. (See p. 18.) They advised us that civil agencies have generally shown a lack of knowledge of technology available outside their own organizations and that, for the most part, focal points of responsiblity within civil agencies for catalyzing the technology transfer process had not been established. This made it exceedingly difficult for the transfer agents to identify civil agency problems and match known Navy technology for potential solutions.

In May 1971 the Logistics Management Institute prepared a report for NASA concerning opportunities to enhance technology transfer. According to the report, the public sector organizations had little scientific and technical expertise and were not experienced in information searches, except, perhaps, in their special areas.

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[1]Interim draft report of the Committee on Scientific and Technical Information, Federal Council for Science and Technology (Sept. 1970).

CONCLUSION

Civil agencies should establish formal active technology transfer methods, including focal points of responsibility and interagency communication, to take advantage of existing Federal technology and particularly those of DOD. We believe that, because of the numerous agencies involved, OMB, in consultation with OST, needs to take the first step to provide policy guidance.

RECOMMENDATION TO OMB

We recommend that the Director, OMB, in consultation with OST, establish a Government-wide policy on technology transfer, including guidelines for formal agency active transfer efforts. Suggested guidelines to consider are listed in appendix II. The guidelines should provide for exemptions from agency personnel ceilings of employees assigned to transfer activities and to tasks for which costs are to be reimbursed by other agencies.

Agency comments and GAO evaluation

In its letter dated April 26, 1972 (see app. VI), OMB told us that:

> "It has long been the policy of the Federal Government to encourage the transfer of Government-developed technology to meet the needs of other Government programs, as well as to help in the solution of problems in the private sector. This policy was reaffirmed in the President's recent message [to the Congress] on Science and Technology ***."

OMB also stated:

1. A policy statement by itself would not result in improved technology transfer; the policy must be implemented through effective and efficient active transfer techniques.

2. A number of active approaches were to be tested beginning in fiscal year 1973, in response to the President's message.

3. There would be studies to improve understandi of how and where Federal technology can be used a . of the institutional barriers to its transfer.

OMB did not agree, however, to provide written guidelines for Federal agency active transfer efforts.

OST said it contributed to the preparation of OMB's comments on our recommendations.

We recognize that there is and has been a general, although informal, policy encouraging the sharing of technical resources within the Government. However, civil agencies differ widely in their approaches to seeking and using these resources. We believe, therefore, that active and effective sharing requires a specific reiteration by OMB to elaborate on the policy, to provide guidelines for reasonably uniform and consistent implementation, and to establish a basis for monitoring compliance. In our opinion, civil agencies need the stimulus that could be provided by an OMB directive encouraging active interagency transfer methods. A statement such as we recommend should provide a framework against which each civil agency could promptly begin to establish its own policies, procedures, and transfer methods in consonance with the President's policy.

The civil agencies whose activities are discussed in this chapter generally agreed to the need for policy guidance from OMB. Some of these agencies specifically supported an OMB policy that would require each agency to establish its own specific guidelines and implementing mechanisms for techology transfer.

CHAPTER 6

PROPOSED CENTRAL TECHNOLOGY TRANSFER CONSULTING TEAM

The communication gap between technology developers and potential users is a significant barrier to the transfer process particularly where their technical disciplines and problems are not similar. Although there are several clearinghouses for passive documentary information collection, storage, retrieval, and dissemination, there is no comparable centralized Federal service to augment active technology transfer process.

Our recommendations in chapters 4 and 5 cover the need for forceful and positive DOD and OMB policy statements endorsing the concept and merits of the active transfer process. Policies, however, are not enough. There must be action, as well, to improve communication between developers and users.

One way to help accomplish this objective is the establishment of a centralized interdisciplinary team of senior professional scientists and engineers who could cross agency lines to assist both generating and using agencies to identify and selectively match potential users with technology. The success of the NASA applications teams and the efforts of the Naval Weapons Center discussed in chapter 3 lead us to believe that some of the concepts used by those agencies could be successfully applied on a Government-wide basis by a Central Technology Transfer Consulting Team.

COMPOSITION AND ROLE OF THE TEAM

The team would serve as consultants to agencies seeking information and guidance concerning the availability of technology and resources relevant to their needs and would advise technology developers of potential secondary applications. The team would deal directly on a person-to-person basis with the using and developing agencies' senior professional staff members assigned to liaison activities to facilitate technology transfer. It could also organize conferences and symposia to discuss problems common to a number of agencies.

The team's size need not be large. It could consis of perhaps 25 to 30 members, of whom about 10 could be pe - manent. The others could be rotating members drawn from other Federal agencies and limited to 1 year's or 2 years' service and thus maintain a dynamic posture. Rotating members returning to their respective agencies after exposure to the team experience should have a leavening influence to foster greater interest, understanding, and motivation in their agencies. The rotating members could consist of one each from the Air Force, the Army, the Navy, AEC, and NASA and one each from interested civil agencies. The team would provide voluntary assistance without attempting to impose an overlay of management control or bureaucratic influence.

Our team proposal should be considered experimental, to be tested on a pilot basis, concentrating on selected areas that are not receiving adequate attention or interagency coordination.

As we visualize it, the team should be organizationally attached to a technology-oriented agency with no vested programmatic or conflicting mission interests. The entire group should be funded by the cognizant agency through a special OMB provision or a separate appropriation. We are not suggesting any specific agency for this role. However, we believe that the National Bureau of Standards (NBS) and NSF warrant consideration. Information concerning these agencies is in appendix III.

Recommendation to OMB

We recommend that the Director, OMB, provide for the establishment of a small technology transfer consulting team as a pilot effort to assist Federal agencies in matching technological resources with their needs for solving pressing national problems.

Agency comments and GAO evaluation

OMB stated that the new efforts planned in response to the President's message might include an experiment with a technology consulting team such as we propose.

The Department of Commerce indicated that NBS would be an appropriate location for the team, especially in view of

its extensive interagency technology activities, which it continually acts as a transfer agent. According to the Department, adequate funding must be provided to support the increased staff that will be needed. Other agencies also expressed concern over the need to obtain funds required to implement our recommendation.

NSF, although agreeing with the objectives of our recommendation, questions the need to establish another organizational level. NSF would prefer having the team members remain in their own organizations doing their technology transfer functions and receive general guidance from their own agencies and an interagency committee.

There is some merit in NSF's suggestion. However, the present DOD consortium arrangement with a single NSF staff liaison member is not adequate, we believe, to fulfill the catalytic linkage role Government-wide, nor even between DOD laboratories and the many potential users. The proposed team would not replace but would supplement and provide a central focus for a network of all technology liaison offices that now exist or may be established within each generating and using agency. Furthermore we believe that the rotating members would gain more perspective and would contribute more effectively in team effort if they were temporarily detailed to group participation and detached from direct obligations to serve only their own agencies. NASA already has established a technology liaison network within its own organization and to some extent with user agencies.

According to AEC, the team concept was not feasible because "No such group would have the requisite disciplinary and detailed knowledge of those agency programs that actually develop technology ***." AEC suggested the following alternatives.

1. User agencies should be exhorted or directed to contact generating agencies to make their needs known.

2. Generating agencies could designate one or more knowledgeable individuals as contact points to assist user agencies in determining where and with whom the user might obtain help.

3. Interagency conferences could be jointly sponsored by generating and user agencies to explore opportunities for matching needs with capabilities.

We do not expect the team to have the detailed kn dge suggested by AEC. Rather, our concept is for the team serve as a catalyst to work closely with knowledgeable p r-sonnel in the agencies developing or possessing technology and with potential users.

All three of the suggested alternatives are consistent with the guidelines we have suggested to OMB for direction to generating and user agencies (see app. II), provided the individuals designated as contact points not only respond to inquiries but also exert positive efforts to make the generating agencies' expertise known to potential users.

NASA also prefers its existing arrangements which allow for direct communications between users of technology and which have proved to be effective. Again, it is not our intention to suggest disturbing or replacing the team concept of NASA's Technology Utilization Program. As pointed out in chapter 3, we consider NASA's approach an excellent model of an active transfer method. We expect that our proposed team, while devoting special attention to coupling the civil agencies with DOD resources, would work closely with NASA's existing organization and would provide even greater benefits.

DOD stated that the use of its technology could be enhanced by better informal arrangements between DOD and the other agencies. The most important aspect of such arrangements, according to DOD, is the identification by the other agencies of specific problems amenable to technological solutions. DOD believes that this problem definition and working relationship could well be done through the proposed consulting team.

CHAPTER 7

SCOPE OF REVIEW

Our review was directed primarily toward evaluating the policies, practices, and procedures within the Government concerning the secondary use of defense technology to solve pressing national problems. It did not include a detailed examination of the performance or management of this effort but was limited to a qualitative comparison of concepts and methods.

We obtained information from Government officials responsible for the formulation of research and development policy and the dissemination of technology to potential secondary users by the Department of Defense, Department of Commerce, National Aeronautics and Space Administration, and Atomic Energy Commission. As part of this effort, we analyzed representative technology dissemination and scientific information collection programs of the Federal agencies with major research and development missions.

We obtained information on Government organizations performing research and development, particularly defense laboratories, regarding technology which may apply to domestic needs other than mission-oriented work. In addition, we talked to potential users of existing technology, primarily Federal civil agencies whose missions included solving pressing national problems, to determine the practices followed in seeking, obtaining, and using technology originally developed for other needs. Discussions also were held with technology transfer agents to identify barriers to technology transfer.

We reviewed congressional hearings and committee reports involving technology transfer and recent related studies by professional organizations.

SUGGESTED DOD GUIDELINES FOR SHARING TECHNOLOGY WITH CIVIL AGENCIES

These suggestions are based, in part, on (1) AEC guidelines, initially established in March 1964, covering research and development for other Government agencies and (2) the policy for expanded interagency cooperation in use of Federal laboratories adopted by the Federal Council for Science and Technology in March 1972.

Where technological resources and capabilities are considered potentially useful for secondary application to meet nondefense needs and where they are not available from other sources, defense research and development centers are encouraged to cooperate with and support civil agencies in using these resources, subject to the following guidelines.

1. Determination should be made that equivalent capability is not available elsewhere and/or that time and cost savings would be expected by using the DOD resource.

2. Active technology transfer efforts and interagency sharing of DOD resources should be undertaken only if they will not interfere with the defense mission.

3. DOD support should be limited to a minor portion of the resources at each defense center, except for interagency joint ventures in which both DOD and civil agencies have mutual interests.

4. Active transfer efforts (including meetings, conferences, travel, and preparation of proposals) may be made, within prescribed limits and conditions, to acquaint civil agency officials with technological innovations and available resources. The cost of such limited efforts may be recovered through allocation to projects for which the civil agencies consummate work agreements. Formal proposals for such work should be prepared and submitted only when requested by a civil agency.

5. Costs of nondefense work shall be subject to prior authorization and reimbursement by the cognizant civil agency.

6. Normally only existing facilities and expertise should be used for interagency support. Where an incidental amount of additional equipment is needed, it may be acquired if authorized by the civil agency. The civil agency will pay for and own the equipment.

7. DOD employees assigned to interagency support and related technology transfer activities, the cost of which is to be reimbursed by nondefense agencies, will be exempted from any existing DOD personnel ceilings during such assignments.

8. Where it becomes apparent that a segment of the research and development activity is more essential to the program needs of the civil agency than to the defense mission, consideration should be given to seeking authorization for transfer of that segment to the civil agency.

9. DOD personnel should be instructed to refrain from aggressive promotion that might be construed as an attempt to proliferate a DOD resource element no longer needed in the defense program.

APPENDIX

SUGGESTED GUIDELINES FOR RECOMMENDED OMB POLICY DIRECTIVE ON INTERAGENCY SHARING OF TECHNOLOGY

All agencies involved in technology generation (i.e., research and development) and/or technology use should establish policy and procedural guidelines, including:

Formal policy statement--Enunciate a technology transfer policy and establish the priority of transfer efforts in the agency's research mission.

Technology liaison staff--Establish a technology liaison office within the research planning function or other central location(s) staffed with senior scientists and engineers having multidisciplinary backgrounds.

Operating procedures--Provide the necessary operating procedures, including the delineation of authority and responsibility for staff to engage in planned efforts to search out and evaluate relevant technology. The procedures should include:

1. Active efforts to seek and use available technology before investing in new facilities and programs. Such efforts should be coordinated with other technology transfer agents and the proposed technology transfer consulting team referred to in chapter 6.

2. Active efforts to identify and promptly make known to other agencies technological innovations and resources available for possible interagency use.

3. Provision for reimbursement of both direct and indirect costs incurred in providing assistance to a user agency at its request.

4. Exemption from agency personnel ceilings of employees temporarily assigned to technology transfer activities and tasks for which costs are reimbursed by one or more other agencies.

APPENDIX III

POSSIBLE ORGANIZATIONAL AFFILIATIONS FOR PROPOSED FEDERAL INTERAGENCY TECHNOLOGY TRANSFER CONSULTING TEAM

As stated on page 39, the team we propose should be organizationally affiliated with a technologically oriented agency with no conflicting mission interests. NBS and NSF warrant consideration.

NATIONAL BUREAU OF STANDARDS

NBS is a principal focal point within the Government for applying physical and engineering sciences to the advancement of technology in industry and commerce. In addition to conducting research, NBS (1) provides technical services to promote the use of available technology and to facilitate technological innovation in industry and Government, (2) cooperates with public and private organizations in developing technological standards and test methodologies, and (3) provides advisory and research services for Federal, State, and local government agencies.

NBS has a long history of successful working relationships with Government agencies and private industry in the development of standards and the solution of national problems. NBS maintains its own laboratories and has the administrative measures to engage private industry assistance for adaptive engineering tasks. NBS has professional stature and acceptance throughout the scientific and technological community, including the Government, professional societies, trade associations, academic and nonprofit institutions, and private industry.

In hearings before the Subcommittee on Science, Research, and Development, House Committee on Science and Astronautics, in July 1971, the Secretary of Commerce stated, in part, that:

> "Our objectives in technology are readily described. We must strive to:
>
> > "Remove barriers impeding the use of existing technology.

"Stimulate better use of existing technology.

"Remove barriers impeding the development and use of new technology.

"Stimulate the development and use of new technology."

* * * * *

"We should examine the feasibility of establishing a single Federal focus for several activities directly related to enhancement, assessment, and forecasting of industrial technology."

* * * * *

"These activities would include: *** Establishment of mechanisms to guide technology transfer."

NATIONAL SCIENCE FOUNDATION

NSF was established to strengthen research and education in the sciences. Its activities include development and dissemination of information relating to scientific resources of the Nation, award of grants and contracts in support of scientific research, support of national research centers, and improvement in coordination of scientific information activities.

NSF has high professional stature and acceptance, especially in the scientific and academic community. It also has established an intergovernmental science information program involving extensive coordination with Federal agencies and the States and local governments. NSF generally engages private sector support through grants to nonprofit organizations.

The mission of NSF traditionally has been oriented toward basic, rather than applied, research. However, NSF has recently undertaken a problem-oriented program called Research Applied to National Needs. The principal purpose of this program is to increase the understanding of social and environmental problems and their underlying causes and through research to identify opportunities for advanced

technology that are of benefit to society. The pro ram also includes an Intergovernmental Science Information Program Office which is responsible for assisting State and local governments to use science and technology in their efforts and stimulating research activities at those levels.

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON, D. C 20301

1 [illegible] 1972

Mr. Harold H. Rubin
Associate Director
(Research and Development)
United States General Accounting Office
Washington, D. C. 20548

Dear Mr. Rubin:

We have reviewed the GAO draft report dated March 2, 1972, "Means for Increasing the Use of Defense Technology to Meet Urgent National Civilian Needs" (GAO Code 86531) and are pleased to offer the following comments for consideration in preparation of the final report.

The Department of Defense supports the utilization of Defense developed technology to meet national civilian needs, and as noted in the GAO report, has taken steps to assist the flow of technology to other government agencies and the private sector. While most of these steps have been "passive" in nature, others have been "active." The working of this "passive" technology transfer method is probably most clearly illustrated in the aeronautical area. DoD developed technology, which covers the entire spectrum from pure and applied research through engineering design and manufacturing methods, is the foundation of our commercial aviation industry. This is the subject of a recent joint DoD-NASA-DoT study, entitled "Research and Development Contributions to Aviation Progress (RADCAP)." Brief descriptions of the RADCAP study results and other representative technology transfers which have occurred in a "passive" way are attached (Attachment 1). [See GAO note 1, p. 51.]

An example of the "active" approach is evidenced within the Department of the Navy which has officially designated a Director of Technology Transfer and established a formal technology transfer program in accordance with the attached instructions (Attachment 2). Further amplifying guidance for the Navy program is currently being formulated.

Our concern with "active" technology transfer activities is t. .ld:

(1) We must assure that such activities do not impair our primary mission, and

(2) We must assure that the overall benefits from such activities are commensurate with their cost.

[See GAO note 2, p. 51.]

While the Department of Defense has traditionally done work for other agencies on a reimbursable basis, we believe that the use of Defense technology by other agencies could be considerably enhanced by a better informal arrangement between DoD and the other agencies. In this regard, we feel that the most important aspect of this arrangement is the identification by other agencies of specific problems which are amenable to technological solutions. This problem definition and working relationship could well be done through the mechanism of the Central Technology Transfer Consulting Team discussed in the GAO

report. However, care should be taken to ensure that this mechanism does not become overly structured in the bureaucratic sense, or that it does not establish formalized administrative requirements which inhibit the informal arrangement process.

If technology transfer, in the sense addressed in the GAO report is to succeed, a program must be established to involve industry in a timely manner. None of the Federal Agencies have a significant production capability, and it would not be appropriate for the Defense laboratories to compete with industry in the production role. Therefore, the involvement of private industry is necessary in order to complete the technology transfer cycle.

The extent of the adaptive engineering work performed by the Defense laboratories is limited by the availability of technical manpower at our research and development laboratories. Only with additional manpower resources can there be a significant increase in the amount of work performed for the civil agencies without interfering with the primary missions of these laboratories. The Department of Defense proposes to address the management problems involved in carrying additional laboratory staff funded by non-DoD sources.

We commend the GAO on the technical excellence of this report. The subject is one of importance to a broad sector of the American public.

Sincerely,

John S. Foster, Jr.

for

Attachments

GAO notes: 1. The attachments are not reproduced.

2. Deleted portion relates to material included in the draft report but excluded from the final report.

APPENDIX V COPY

THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

June 21, 1972

MEMORANDUM FOR Secretaries of the Military Departments
Director of Defense Research and Engineering
Assistant Secretary of Defense (Comptroller)

SUBJECT: Non-Defense Work in DOD Laboratories and R&D Facilities

Civil government agencies are expressing an increase interest in the application of defense and aerospace technology to the solution of problems in the civil sector. Included in this interest is the desire to exploit the technological expertise which exists in our DOD laboratories for the solutions of domestic problems. Separate and distinct from work done for defense oriented agencies such as AEC and NASA, our DOD laboratories have, for many years, performed selected projects for other agencies upon request. Recently, fifteen of these laboratories have formed a consortium for the purpose of coordinating the non-defense work being performed by them for other government organizations. Although the level of effort is a very small percentage in these laboratories at the present time, the aggregate can have a substantial beneficial impact on domestic programs.

It is generally conceded that the most efficient transfer of technology occurs when the adaptation of a technology to a new purpose is carried out by the team which carried out the original development. Recognizing this, the Federal Council on Science and Technology (FCST) has approved a "Policy for Expanded Interagency Cooperation in Use of Federal Laboratories" (attached). I endorse the spirit and intent of this policy.

The Military Services are encouraged to participate in this endeavor consistent with mission and legislative constraints. The level of effort in any laboratory is the prerogative of the cognizant Military Department which may, in turn, issue more detailed policy guidance as appropriate. Any Military Department policy shall be subject to the following considerations:

(a) The level of effort of the work undertaken shal be such that it does not impede the accomplishment of the missions of the Military Services and the defense laboratories.

(b) The projects selected for non-defense work shall be compatible with the technological capability of the laboratory performing the work.

(c) Projects may be undertaken in support of federal, state and local government organizations. Non-defense work will be performed for the private industrial sector only on an exception basis.

(d) The full costs of projects undertaken shall be supported by transfer of funds through formal written agreements.

(e) Jointly sponsored projects are permitted when there is also a direct application to a Military requirement. The commitment of funds and resources to joint programs shall be commensurate with the interest of each agency in the project.

The Assistant Secretary of Defense (Comptroller) shall explore with the Office of Management and Budget means for providing relief from any imposed manpower constraints to the extent of the DOD participation in non-defense work.

signed by
Kenneth Rush
Deputy

Attachment -
as stated

EXECUTIVE OFFICE OF THE PRESIDENT
OFFICE OF MANAGEMENT AND BUDGET
WASHINGTON, D.C. 20503

APR 26 1972

Mr. Harold H. Rubin
Associate Director
Defense Division
General Accounting Office
Washington, D.C. 20548

Dear Mr. Rubin:

We have reviewed your draft report on Means for Increasing the Use of Defense Technology to Meet Urgent National Civilian Needs, and we appreciate the opportunity to comment.

We were pleased to note that the draft report emphasizes the importance of "active" methods of improving technology transfer. We believe that previous studies of this problem have focused too much attention on "passive" technology transfer methods, which the report defines as "collection, processing, and dissemination of technical documents on request of potential users," and too little attention on the direct interplay between the technology developers and potential users. As noted below, the President has recently proposed actions to explore how this interplay can be made more effective.

Your draft report focuses on the transfer of technology from the Department of Defense to Federal civil agencies, although the proposed recommendations for OMB action are much broader and cover the general issue of matching technological resources with pressing national problems. Our comments below speak to the general issue of the Federal role in improving the transfer of technology, rather than the more limited issue of the role of the Department of Defense in such technology transfer.

We have the following comments on the specific "recommendations or suggestions" included in the report:

1. Recommendation

The Office of Management and Budget, in consultation with the Office of Science and Technology, should establish a Government-wide policy for technology transfer and promulgate guidelines for Federal agency implementation of formal active technology transfer processes.

OMB Comment

It has long been the policy of the Federal Government to encourage the transfer of Government-developed technology to meet the needs of other Government programs, as well as to help in the solution of problems in the private sector. This policy was reaffirmed in the President's recent Message on Science and Technology, in which he stated that:

> "An asset unused is an asset wasted. Federal research and development activities generate a great deal of new technology which could be applied in ways which go well beyond the immediate mission of the supporting agency. In such cases, I believe the Government has a responsibility to transfer the results of its research and development activities to wider use in the private sector."

However, a policy by itself will not result in improved technology transfer. Effective and efficient methods of technology transfer are needed to implement the policy and many different methods are needed to meet the many different transfer situations. For example, methods for transferring technology between Federal agencies may not be effective in transferring technology to State and local governments or to the private sector. An important factor to consider is that Federal agencies dealing with domestic problems such as transportation, housing, health or education, can accomplish their objectives only with substantial voluntary participation by State and local governments, industry, colleges and universities, and other non-Federal institutions. In these cases the transfer of technology among the Federal agencies is not sufficient; it must also be transferred to and among many organizations outside the Federal Government.

Therefore, the President's FY 1973 Budget and his Message on Science and Technology provide for the exploration of several different "active" approaches to improving technology transfer. In some cases the approaches are to be implemented in 1973, while in other areas there will be experiments to determine the effectiveness of transfer techniques. There also will be studies to improve our understanding of how and where Federal technology can be utilized and the institutional barriers to its transfer.

Briefly, these initiatives include the following:

a. The capabilities of our high technology agencies, such as NASA and AEC, will be used more directly in applying research and development to domestic problems. These agencies will work closely with the Federal agencies with principal responsibilities for dealing with domestic problems. A principal objective of this effort is to ensure that technology now available is used whenever appropriate to solve domestic problems, as well as to utilize the scientific and engineering talents of these agencies to help apply the technology to domestic problems. Examples of problem areas in which the high technology agencies will participate in 1973 are transportation, housing, energy and natural disasters.

b. The National Science Foundation and the National Bureau of Standards are to initiate programs of experiments to find effective ways of improving the application of science and technology to social and economic problems. These programs are expected to include experiments with alternative "active" approaches to the transfer of Government-held technology. Joint efforts between Federal R&D activities and a wide range of potential users of the R&D results are expected to be supported and evaluated as possible mechanisms for enhancing technology transfer.

c. The National Science Foundation is to undertake a National R&D Assessment effort, which will include analyses of how science and technology might be used more effectively in the civilian sector, and studies of the social, legal and economic barriers to the transfer and application of science and technology.

d. The President has directed his Science Adviser and the Secretary of Commerce to develop plans for a new, systematic effort to promote actively the licensing of Government-owned patents in order to promote the transfer of technology into the civilian economy.

2. Recommendation

The Office of Management and Budget should provide for the establishment on an experimental basis of a technology transfer consulting team as a central focus to assist Federal agencies in the matching of technological resources with pressing national problems.

OMB Comment

As indicated in our comments on the previous recommendation, it is planned that the National Science Foundation and the National Bureau of Standards will experiment with several alternative approaches to improve the application of technology from Federal R&D activities to deal with important social and economic problems. Also, the high technology agencies themselves will become more directly involved in such problems. These efforts may include an experiment with a technology transfer team such as described in your draft report as one possible mechanism for improving technology transfer.

In summary, we believe that the actions proposed in the President's 1973 Budget and his Science and Technology Message will be important steps in improving the technology transfer process and will largely fulfill the proposed recommendations of your report. We suggest that the draft report be revised to note these recent actions by the Administration.

At this point, I believe it is important to stress that improved technology transfer by itself is not likely to go far toward solving significant national problems. In some cases, available technology will not be suited, because of cost or other factors, for application to domestic problems. Also, technology is likely to play a relatively small role in the solution of most national problems. Accordingly, the Administration's efforts to improve technology transfer are only a small part of a broader strategy to encourage and support the social, economic and technological innovations which will be necessary in order to resolve most of our serious domestic problems.

Sincerely,

George P. Shultz

Director

APPENDIX VII

AGENCY OFFICIALS RESPONSIBLE FOR ACTING ON MATTERS DISCUSSED IN THIS REPORT

DEPARTMENT OF DEFENSE

SECRETARY OF DEFENSE:

Melvin R. Laird

DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING:

Dr. John S. Foster, Jr.

OFFICE OF MANAGEMENT AND BUDGET

DIRECTOR:

Caspar W. Weinberger

OFFICE OF SCIENCE AND TECHNOLOGY

DIRECTOR:

Dr. Edward E. David, Jr.