The goal of the Bureau of Mines is to help assure an ample and dependable supply of minerals and mineral fuels from diversified sources at reasonable prices and at minimum social cost in the form of environmental pollution and sickness, and injuries to the men who must work in the minerals industries.

To achieve this end, the Bureau encourages and provides research leadership in developing new science and technology leading to economic and safe extractive processing and utilization of the Nation's mineral and mineral fuel resources. Inasmuch as the private industrial sector is the principal producer and consumer of minerals and fuels, the industry benefits from the Bureau's scientific research and investigations, and its mineral economics, resource, and statistical studies.

The Geological Survey's program is national in scope and has these comprehensive objectives: to complete the topographic mapping of the United States according to national standards and to maintain the maps in up-to-date condition; to complete the geologic mapping of the United States according to national standards; to appraise the water, mineral, and mineral-fuel resources of the United States; to classify and appraise the mineral value of federally owned lands; to supervise extraction of minerals and mineral fuels from federally owned lands under lease; and to carry on research in the principles and instrumentation of surveying, hydrology, geology, geophysics, and geochemistry, and related subjects.

With respect to (a), the above activities are carried out through four operating Divisions—Topographic, Geologic, Water Resources, and Conservation—whose programs are closely interrelated, for example, topographic maps are the base for compilation of geologic maps, and for mineral and water resources studies and investigations; and geologic maps are basic to water resources studies and investigations and to determine the mineral and waterpower potential and proper classification of public lands.

With respect to (b) and (c), because the Survey's programs are approached from the standpoint of national goals and needs, other Federal agencies and the private industrial sector benefit from and use the results of the Geological Survey's surveys, investigations, and research in a manner similar to that described above.

2 (a), (b), and (c). Reclamation R. & D. efforts have been mission oriented to solve immediate and long-range problems arising in its planning; design, construction, and operation and maintenance programs. In testimony before the Appropriations Committees, we have shown that benefits derived from such efforts have had dollar value as much as 10 times the cost involved. These savings have been realized through better uses of materials; proven applications of new materials; improved construction, operation, and maintenance methods; and refined planning techniques leading to safer and more economical structures. Virtually all findings have applications among Federal agencies and in the private industrial sectors concerned with water resources activities. We also believe that the product derived from:

(a) The biological and technological research conducted by the Bureau of Commercial Fisheries is necessary if the agency is to have available the information needed to meet its responsibilities and objectives for conservation and management of fishery resources.

(b) Information gathered by the Bureau about the environment and its resources is used by other agencies within Interior (Bureau of Sport Fisheries and Wildlife, Geological Survey, Federal Water Pollution Control Administration, etc.) other departments in the Federal Government (Department of Defense, Health, Education, and Welfare, Atomic Energy Commission, Commerce, etc.), and by State governments. Information provided by the Bureau is particularly useful to States in the management of fishery resources within their territorial waters.

(c) One of the Bureau's major objectives is to strengthen and maintain a vigorous fishing industry and many of its research and service activities are directed toward this end. Although many of our research results are immediately and directly applicable to industry's needs and problems, much greater effort needs to be spent in improving this transfer of information and technology.

The technology identified, collected, and organized by the Bureau of Sport Fisheries and Wildlife is essential to our own agency for the interpretation of problems of fish and wildlife and environmental management and in discovering ways to solve them. Some aspects of our technology are of considerable value to other Federal agencies in the general resource management field, such as the U.S. Forest Service. The private industrial sector has relatively little application for our own technological developments.

### 7. FEDERAL AVIATION AGENCY

(a) All FAA research and development is directly initiated by and applicable to established requirements for the national airspace system. Requirements are verified on a staff level and technical results are applied through functions on development and operational levels within the Agency.

(b) There is a high degree of applicability and value of technology derived by the FAA to the Department of Defense and the National Aeronautics and Space Administration, where an overall commonality of interest exists, and in diminishing degree to other Federal agencies such as Department of Commerce, Department of Interior, Department of Health, Education, and Welfare, U.S. Coast Guard, and others, which have interest in specific areas. For example, a considerable amount of technology exchange is experienced between the FAA and the Bureau of Standards and Environmental Science Services Administration, Department of Commerce. Such exchanges are not only applicable and valuable but mandatory for successful conduct of mission.

(c) Derived technology also has a high degree of value and applicability in the private industrial sector. This is obvious in the case of supersonic transport development, but exists also in the general areas of avionics system and component development, aircraft engineering and safety development, and aviation medical technological research. Many examples could be cited, such as airborne radar beacon transponder equipment, navigation instrumentation, airframe and propulsion system improvements, emergency oxygen dropout mask and equipment, and a host of others. These developments benefit not only primary equipment manufacturers but affect in turn many component supplies.

### 8. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

This Department creates technology as one of its primary missions—for the express, integral purpose of distributing it to the health and scientific community, both public and private, industrial and nonprofit. Likewise, we support and engage in a vast range of information activities because of their vast potential to improve the life of our society and the individual within it. To do this implements the resolution of the President to utilize all of our resources economically and to the fullest extent toward solution of health and other problems.

## D. POLICIES FOR TECHNOLOGY TRANSFER, QUESTION 3

The two Federal agencies which generate the most technology (NASA and DOD) have radically different policies for collecting and disseminating the information. NASA requires its contractors to report not only inventions and innovations but the underlying ideas and techniques. The costs of reporting are allowable under the contract. The information is then processed through an elaborate agency-operated system. Finally, a variety of experimental dissemination centers make contact with industry and aid in finding applications. NASA follows a take-title patent policy although the Administrator frequently waives this right when, in his judgment, the public interest will be served.

The Department of Defense believes that the normal incentives of the patent system are sufficient to guarantee the public interest will be served in exploitation and development of the technology for civilian use. Patent rights are usually passed to the R. & D. contractor. The DOD information dissemination policy is heavily influenced by national security considerations. Beyond the secret and confidential classification, a category of "unclassified but restricted" is used for private proprietary information. According to information furnished to the subcommittee, "Due to distribution limitations imposed by security classification, proprietary rights and other controls, the defense documentation center was only able to release 16,000 of the more than 50,000 documents received to the clearinghouses for Federal scientific and technical information in fiscal year 1965."

Assuming roughly equivalent dollar value, this means that 68 percent of the DOD research and development effort in that period (about $7 billion) is not available for secondary application in other industries. This amounts to almost $5 billion or one-third of all the federally sponsored R. & D. in that year. Rendering such a substantial portion of technology unavailable poses a serious question for future policy planning in transfer programs.

The Atomic Energy Commission operates under important security restraints. However, its mission to develop civilian power reactors has evolved an elaborate dissemination system. For more general purpose technology, the AEC has begun to operate Offices of Industrial Cooperation at Argonne and Oak Ridge National Laboratories. A program of cooperation with NASA in originating "brief industrially oriented summaries of its innovations" suggests that AEC policy is sympathetic to a purposeful transfer program.

DHEW does assist State and private laboratories in applying new techniques such as automated analytical procedures developed by the National Institutes of Health.

Somewhat surprisingly, the Department of Commerce "does not have any organized program to pursue new applications of DOC funded technology." In contrast to the NASA theme, the State Technical Services information is "not pushed or broadcast from a central Federal agency."

Detailed replies from the agencies are presented below.

### 1. NATIONAL AERONAUTICS AND SPACE AGENCY

All NASA contracts for research and development contain clauses obligating the contractor to report to NASA the new technology first conceived or reduced to practice in the performance of that contract. New technology is broadly defined to include inventions, innovations, improvements, and discoveries—thus including, for example, computer programs. The NASA definition of new technology is contained in NASA Handbook for Reportable Items. NASA further asks those contractors working on major projects to submit their plans for identifying, documenting, and reporting this new technology. This NASA requirement is spelled out in NASA Procurement Regulation Section 3.501–(b)(1x). To assist the contractor in devising a proper plan, NASA has published an additional NASA Handbook.

Importantly, NASA asks its contractors to describe the concepts and principles underlying the specific inventions and innovations made under contract. This is essential to successful technology transfer because most "transfer" takes the form of someone proceeding from such underlying concepts and principles to design an analog of the hardware item NASA required. In other words, the specific piece of hardware resulting from a given development program generally has far less capability for transference than does the knowledge underlying that hardware.

Each NASA field installation has a technology utilization office, staffed by one or more experienced engineers and scientists who administer the new technology clause in contracts let by that installation and who identify, document, and report the new technology generated through inhouse work at that installation. These men also evaluate the technology reported by contractors to determine its novelty and the completeness of the documentation. Where necessary, these items are further evaluated for novelty, practicality, and utility by independent research institutes. The new technology which survives this screening is published by NASA in one of several formats: (*a*) The Tech Brief. This is a brief announcement of the innovation, designed to provide only sufficient information for the potentially interested engineer, scientist, or businessman to determine the relevance of the information to his requirements. Some tech briefs are complete descriptions of the innovations. More, however, are simply announcements and interested parties can obtain additional information ("backup packages") by writing to the technology utilization officer whose address appears on the Tech Brief. Further, the interested reader of a tech brief can call the technology utilization officer with specific questions and the officer will seek to obtain answers from the innovator or other expert at his installation and reply

to the inquirer. (*b*) More complex or more immediately significant innovations are often published by NASA as technology utilization reports. (*c*) Some related incremental advances in the state of the art are published as compilations.

NASA also publishes technology surveys. These are written under contract to NASA by authorities in a field to which NASA, in the course of its projects, has made significant contributions. These surveys are designed to guide the reader to recent advances in a given technical domain and to guide him to sources of additional information on those advances.

Many means of dissemination are employed in the NASA technology utilization program. More than 1,000 trade, technical, business, and professional publications receive NASA tech briefs and technology utilization publications that fall within the interest areas of their audiences. Any U.S. citizen can be placed on a technology utilization mailing list to receive announcements of NASA technology utilization publications and tech briefs. NASA tech briefs and technology utilization publications are sold by the Government Printing Office and the Clearinghouse for Federal Scientific and Technical Information.

The eight experimental regional dissemination centers sponsored by NASA make available not only the technology utilization publications but the complete unclassified storehouse of information collected by NASA on a worldwide basis to support the needs of scientists and engineers working on NASA projects. This information bank now contains a collection of nearly 220,000 documents, all abstracted, indexed, categorized, and filed on computer tape. Member companies at regional dissemination centers pay annual membership fees for the value added to this information at the regional dissemination center via the professional staff of that center assisting in problem and objective definition, designing search strategies and interest profiles, screening documents for relevance, interpreting results, and providing other services aimed at getting the right information to the right person at the right time. The regional dissemination centers are also equipped to serve as regional resources for the designated institutions under the State technical services program of the Commerce Department. NASA also sponsors and participates in conferences, symposia, workshops, and seminars to transfer technology. NASA has also recently supported the establishment of three biomedical application teams at three research institutes. These teams establish interinstitutional relationships with medical research groups at universities, clinics, research hospitals, and Government medical research institutions. The teams work with the researchers to define specific barriers to the forward progress of biomedicine. These barriers are then divided into their components and described in functional terms in the form of a problem abstract. These abstracts are then circulated to NASA field installations.

Meanwhile, a search of the NASA information bank is completed. The responses from the field installations and the results of the literature search are then compiled and organized by the teams and presented to the research groups as partial or complete solutions to the barriers. Examples of transfer achieved in this way can be made available to the committee if desired. NASA also employs many more traditional means of dissemination, as explained in "How To

Use NASA's Scientific and Technical Information System." Some of the NASA technology utilization dissemination means are described in, "NASA's Technology Utilization Program." NASA is also experimenting with additional mechanisms to disseminate and communicate new technology. Through all of these mechanisms, NASA provides the means for potential users of NASA-derived technology to actively and efficiently pursue additional applications for this technology.

### 2. DEPARTMENT OF COMMERCE

*(a) Identification and reporting*

Each NBS and ESSA scientist is encouraged to report all significant scientific and technical advances. Also, all in-house or contract work in the Bureau of Public Roads, High Speed Ground Transportation, and the Maritime Commission is required to be published or reported in some suitable form at the earliest practical time. For example, NBS alone produces about 1,200 technical publications per year.

*(b) Organization and evaluation*

The Department of Commerce has two important programs in this area.

First, the NBS sponsors the National Standard Reference Data program which operates or coordinates 28 information and data centers, (12 of them in NBS) for the organization and evaluation of technical data. The data, however, are produced by both federally supported work and all other work.

Second, the Clearinghouse for Federal Scientific and Technical Information, which is discussed in more detail in the next section, has, for over a year, been making a systematic evaluation of all federally sponsored research reports which they receive, identifying those which appear to be of unusual significance (about 10 percent of all reports), and then issuing a special monthly Fast Announcement Bulletin in 60 selected categories of high industrial interest. The subscribers to this bulletin pay $5 per year and currently number 6,500, and have been rapidly increasing. Over 90 percent of them are outside the Federal Government. In their evaluation of significance, the Clearinghouse staff often uses other DOC scientists and engineers as consultants. Because of its (nearly) comprehensive coverage of federally supported work and its selective focus to different categories of users, we believe this service will prove to be of unusual value in the dissemination of the results of federally supported science and technology.

*(c) Publication and dissemination*

In ESSA, Transportation, and Census, publication of technical work is sent to appropriate technical journals, published by the GPO, or is prepared in the form of reports which are sent to the Clearinghouse.

In NBS, in addition, as we have noted above, there is a 3-section Journal of Research and 8 series of nonperiodical publications, all published by the GPO, whose subscribers number in the 3,000 to 6,000 range.

The Patent Office publishes all U.S. Government-owned patents released for license by the public in the weekly, Official Gazette. In addition, the Clearinghouse has published a series, Abstracts of Gov-

ernment-owned Patents, which covers all patents released prior to December 1963. Thus, the existence and nature of all Government-owned patents are presently available to the public in an indexed and organized form.

One of the largest DOC activities in the area of the dissemination of federally supported technology, however, is the Clearinghouse. This organization has a file of some 500,000 unclassified technical reports and foreign translations. The reports cover most of the unclassified Federal work since 1945 not otherwise published. At present, acquisitions of technical reports are received at the rate of 22,000 per year from all Federal agencies. It is estimated that this is about 80 percent of all the unclassified material of this type suitable for public distribution, and efforts are continuing to locate and procure the balance which is mainly scattered throughout the Government in a large number of places.

In addition, the Clearinghouse receives and announces about 22,000 translations of foreign technical documents per year.

Its main announcement bulletin, the U.S. Government Research and Development Reports, goes to about 4,000 subscribers throughout the Federal Government, the Nation, and the world, and results in the distribution of some 1.8 million documents (in both hard copy and microfiche). A little over one-half of these went to the DOC and its contractors, and the balance to other users, who paid $1.3 million for the services.

The Clearinghouse provides one other announcement bulletin and limited referral services. It is at present the only single point of contact which connects a user in another agency or outside the Government to all the unclassified federally supported technology not published in the open literature.

Finally, the DOC is heavily involved in disseminating not only federally supported technology, but all other technology through the recently established Office of State Technical Services. This organization has cost-sharing programs in 54 States and territories, and is currently working directly with over 102 participating institutions [1] in the dissemination of science and technology to business, commerce, and industry. It is anticipated that this number will rise to 500 or more as the program grows. We believe that, when fully developed, these participating institutions will form the most effective single link between federally produced technology and local needs. The participating institutions are close to the potential users of science and technology, understand their needs and, therefore, can form the highly selective links to the stores of information in the Federal Government or anywhere else which are necessary to meet the local needs. In this concept, technical information is selectively pulled out of the store according to local initiative and need, and not pushed or broadcast from a central Federal agency. Most of the needed information or techniques will not come from Federal programs. The best current understanding of the technology transfer process, which we will expand upon in answer to question 4, below, indicates that this is the most efficient way. One of the goals in the program is to develop a very large number of regional centers at or associated with the participating institutions, which organize and store technical information tailored sharply to the interests and needs of local commerce and industry.

[1] These are primarily colleges, universities, and qualified nonprofit institutions.

Since State and local funds will be used to finance at least half of the budgets of these centers, there will be an unusually strong tendency to focus—as is the intention—on local interests. Purely Federal support would not, in general, be so sensitive to local needs.

*(d) The active pursuit of new applications*

The DOC does not have any organized program to pursue new applications of DOC funded technology.

### 3. DEPARTMENT OF DEFENSE

Developments in the course of research projects are identified and reported by the military departments and defense agencies to the Director of Defense Research and Engineering who maintains an active liaison for the exchange of information within the Department and coordinates actions as appropriate with those activities having collateral or related functions in their respective fields of assigned responsibility. The primary distribution of these reports is made directly to DOD organizations having a known interest in the results and the reports are made available for secondary distribution to DOD and other Federal activities, their contractors, subcontractors, grantees, and to potential defense contractors. This wide dissemination permits the use of the scientific and technical information in the pursuit of other Government applications.

With respect to the identification and utilization of Defense-developed technology in the private industrial sector, it is the policy of the Department of Defense to encourage contractors to exploit unclassified technology resulting from Defense-sponsored research and development within the private sector. The Department recognizes that the prompt exploitation of technological developments resulting from Government-sponsored research by the civilian community is desirable so that public can benefit from the civilian use of such achievements. To best serve this goal the Department's patent policy is designed to provide for the prompt passage into the civilian economy of scientific and technological developments by means of either acquiring title to inventions coupled with liberal licensing arrangements for industry, or by retaining an irrevocable, nonexclusive, royalty-free license for governmental purposes and allowing the contractor to retain title in situations where the normal incentives provided by the patent system are a sufficient guarantee that the inventions will be exploited and developed for civilian use.

### 4. ATOMIC ENERGY COMMISSION

The general statements of policy, purpose, and principle contained in the act have been interpreted rather broadly by the Commission and a comprehensive program for the collection, dissemination. and organization of information related to atomic energy has been established.

The basic language of the contract and of the AEC Procurement Regulations detail the requirement for a contractor to document the results of its research and development and to submit these documents to the Division of Technical Information for dissemination. Various chapters in the AEC Manual explain more explicitly the procedures for

preparing documents, including the security and classification requirements, and for the dissemination of such documents.

By policy and instructions, the AEC has stated that both classified and unclassified information resulting from Commission sponsored research and development, regardless of the format in which it is published, must be disseminated within the AEC family and to other Government agencies and their contractors. The classified publications are distributed to each of these organizations through a subject category system after a determination of the facility's "need-to-know." The unclassified publications also are made available to the general public in the United States and abroad. They are distributed, free of charge, to some 175 AEC depository libraries located in 46 States, and in 55 foreign countries and four international agencies. Most of the unclassified documents, with the exception of commercial publications are made available for sale through the Clearinghouse for Federal Scientific and Technical Information.

The scientific and technical information is disseminated in many formats such as: reports, journal articles, monographs, engineering materials, conference proceedings, translations, bibliographies, computer codes and programs, state-of-the-art reviews, data compilations, press releases, motion picture film and popular level booklets.

Realizing that a considerable amount of research and development is conducted by other organizations, the Commission has developed an extensive exchange program. Arrangements have been made for AEC contractors to receive regularly reports issued by NASA and the DOD which are needed to support their activities. Many exchanges have been instituted with private organizations in the United States and in some 45 foreign countries which have programs in the field of atomic energy. The material received from abroad is made available to the AEC contractors, other Government agencies and their contractors and to the general public in the United States. The foreign reports are distributed similarly to the QEC reports while the commercial publications are deposited in an AEC library and made available on a loan basis.

Since some of the documents received from abroad are in foreign languages, the Commission has established a program of translating these publications as required. The translations are distributed within the Government. The noncopyright material is distributed to the AEC depositories and is sold by the Clearinghouse. Copyright publications are deposited in the Translations Center, John Crerar Library, Illinois Institute of Technology, and may be borrowed by private organizations.

It was realized as early as 1948 that the body of literature on nuclear science and technology would be useless unless it was brought under bibliographic control. "Nuclear Science Abstracts," begun in that year by the AEC, has indexed and abstracted in excess of 250,000 unclassified items and during 1966 will announce more than 55,000 items. These items include reports, journal articles, books, patents, theses, translations, conference proceedings, engineering materials, state-of-the-art reviews and bibliographies. "Nuclear Science Abstracts" is distributed to all organizations receiving AEC reports, to the AEC depositories and to universities working in the field of atomic energy. It also is sold through the Superintendent of Documents.

The Division of Technical Information of the AEC with its comprehensive collection of literature on atomic energy serves as a documentation center. It prepares "Nuclear Science Abstracts" and other bibliographic publications and answers inquiries received from Government agencies and their contractors, private industry, universities, and the general public.

It is worth mentioning that the Commission has carried out a rather extensive and continuing declassification review. A considerable portion of the technology that formerly was classified has been declassified and the information made available to the public. Currently more than 80 percent of the documents are issued initially as unclassified publications. Additionally, the AEC through its access permittee program makes certain classified documents available to industry when needed to support commercial ventures in the nuclear field.

The Commission encourages its employees and those of its contractors to publish through the scientific and technical societies and commercial publishers and has for many years assumed "page charges" to help support the professional society publications.

Other types of information activities of interest include the exhibits which are held at national scientific, technical or industrial meetings and at State fairs and the lecture demonstration programs presented at high schools throughout the country using specially trained subject specialists.

However, because of the highly specialized nature of the literature, the Commission has established information and data analysis centers. These centers are manned by scientists or engineers who are specialists in the subject field covered by the center. The primary functions of these centers are to prepare state-of-the-art reviews or data compilations and to provide specific information in response to inquiries (not just lists of documents). The services of these centers are available to everyone and the publications are made available as as reports or commercial publications.

Because the literature is so extensive and the information on a specific subject appears in numerous publications, the Commission sponsors various publications to summarize the literature. In the journal field, the AEC publishes four Technical Progress Reviews: Nuclear Safety, Reactor Materials, Isotopes and Radiation Technology, and Power Reactor Technology. These journals contain articles reviewing the current status of various programs, descriptions of new developments and state-of-the-art reviews.

The Commission also sponsors books and monographs on specialized topics related to the field of atomic energy, written by outstanding specialists. These publications are made available through commercial publishers. In a related effort the AEC also sponsors semiprofessional level booklets which are made available through the Commission to the general public.

From this brief review it can be seen that the Commission has an extensive program for making the results of its research and development available within the agency, to other agencies, and their contractors, to industry, to educational institutions, and to the general public. A considerable amount of technology transfer has resulted from these efforts; however, it is impossible to obtain reliable feedback to determine the exact extent of the transfer. This "lack of feedback" problem is a major difficulty in determining the value of any technology utilization program.

While the dissemination program is an important transfer mechanism, there are many other activities which bring about significant transfers.

1. Products, processes, and techniques developed as a result of AEC industrial contracts, subcontracts or procurement actions frequently are transferred to the commercial field. For example, a radiation detection instrument, a use of isotopes in nondestructive testing or a method of chemical anaylsis may be developed as part of an AEC program. If the item has general use in the atomic energy field, the company may arrange to produce the item on a commercial basis.

2. The Atomic Energy Act, in Chapter 4: Research, authorizes and encourages the Commission to conduct research and development activities for the purpose of, in part, advancing the civilian technology and carrying out educational and training activities for educational and charitable institutions and hospitals. The Commission through its industrial participation program has provided support to the civilian power reactor effort and has transferred to industry certain operations initially performed within the AEC family, such as the production of isotopes, reactor fuel reprocessing, the manufacture of fuel elements.

3. One of the best, but most expensive, means of transferring technology is by person-to-person communication. The Commission has sponsored or supported numerous conferences, seminars, and workshops and has encouraged its personnel and those of its contractors to participate in professional, industrial, and civic meetings. The AEC also encourages visits by industrial and other personnel to AEC facilities as a means of providing firsthand knowledge of technical developments.

4. The transfer of certain licensing and regulatory functions to the States, under agreements with the Commission, has transferred technology also.

5. AEC policy permits AEC contractor employees to serve as consultants to industry when commercial services are not available. Also industry may arrange to have its employees work at an AEC facility. Both of these activities are conducted on a cost reimbursable basis.

6. The Commission has opened many of its facilities to the general public through conducted tours, or individual visits for business purposes. The traffic through these facilities is extensive. For instance, the recorded total of visitors at Argonne during fiscal year 1966 was some 8,800; the actual total probably was considerably higher since not all visits are recorded.

While these activities had resulted in a considerable transfer of technology, the Commission decided in 1963 to conduct an overall review of its efforts to determine the character and extent of the technology that had been transferred. The following generalizations can be made from the information obtained during this review:

1. Most of the transfers involved nuclear related items or innovations which could be readily adapted for commercial use and resulted from some direct contact by industry with the Commission.

2. There was a tendency for the transfer to occur with medium-sized and large industries that have the necessary information and research staffs to identify, evaluate, and adapt innovations.

3. The existing scientific and technical literature produced as a result of AEC sponsored work was written for practicing scientists and engineers, not business management. The authors in these documents discussed the results of the overall research program. Little emphasis was given to the various items of technology which contributed to the research program.

4. It was determined that a substantial body of nonnuclear technology existed which, if more effectively brought to industry's attention, might have potential commercial applications.

As a result of this study, the Commission issued a directive which specifically encouraged the transfer of nonuclear technology and authorized contractors to provide consulting and on-site work in the nonnuclear area when such services are not available commercially. These services are provided on a cost reimbursable basis.

The Commission has taken a varied and experimental approach to its transfer program partly because no one mechanism has proven to be the most effective for all purposes and because the different segments of industry tend to use different transfer mechanisms as the means of identifying new developments.

As one result of the study, it was decided to establish Offices of Industrial Cooperation at major AEC installations in an effort to develop a more coordinated approach to the technology transfer activity. Two offices, one at Argonne National Laboratory and the other at Oak Ridge National Laboratory, were established as pilot operations. The principle functions of these offices are: to sponsor industrial meetings and tours, to arrange visits by individuals from industry, to answer inquiries, to publicize the AEC's technology transfer program and to identify and announce innovations. The AEC and these offices have expended considerable efforts to keep abreast of new developments in the technology transfer field and to coordinate their activities with the National Aeronautics and Space Administration, the Small Business Administration, the Office of State Technical Services of the Department of Commerce, and with the Clearinghouse for Federal Scientific and Technical Information. In a pilot program established at Argonne, the AEC has held a series of meetings, cosponsored by these agencies, for various segments of industry in the greater Chicago area. For example, one meeting involved the Tool and Die Institute, another the metalworking industry, and a third the electronics industry. The agencies explained to the industrial representatives the extent of the Government's transfer activities and specifically how industry could benefit. The representatives also were given a tour of those Argonne facilities of interest to them.

In another experimental program, Argonne has begun to prepare brief, industrially oriented summaries of its innovations. Many items from the patent disclosure file which were not of interest to the Commission or which were not patentable will be announced as a result of this effort. In addition, Argonne personnel are submitting, voluntarily, items which were not considered to be patentable. As a result of an agreement between the AEC and NASA, Argonne will identify the innovations and prepare the announcements while NASA will assist with the evaluation and editing and will publish the briefs. These summaries and those resulting from the joint AEC–NASA research and development programs will be identified as "AEC–NASA Tech Briefs" and will be disseminated as part of the existing "NASA

Tech Brief" program. Incorporating the AEC briefs into the existing system should be of substantial benefit to industry since those organizations already receiving the NASA material will automatically receive the AEC items.

Based on our experience to date, we believe that these Offices of Industrial Cooperation can serve as a valuable link in the technology transfer process. To date the program has been modest but the Commission plans to establish two additional offices in fiscal year 1968 if the funds become available.

Should it become national policy for the Government to foster the transfer of technology, it would be necessary for the Commission to establish a more comprehensive program to fully exploit its technology.

### 5. DEPARTMENT OF AGRICULTURE

The identification and reporting of the principal findings of research has been considered as an essential phase of the research undertaking throughout the history of this Department's effort in this field. The act establishing the U.S. Department of Agriculture directed that the new agency "acquire and diffuse among the people of the United States useful information on subjects connected with agriculture in the most general and comprehensive sense of that word * * *"

The Experiment Station Act of 1887 providing one of the first authorizations for Federal grants for research specified that moneys provided for payments to State agricultural experiment stations should be for the purpose of paying necessary expenses of conducting investigations and printing and distributing the results thereof. This proviso has been carried forward through each act supplementing this basic authority.

A basic requirement covering the negotiation of research contracts is that the description of the work shall disclose as well as possible the research objective sought, the methods of approach, and evaluation of results obtained.

A description of the Department's major scientific and technical information activities, including the educational programs carried out by the extension service is attached in response to that portion of the question pertaining to the organization, evaluation, publication, and dissemination of scientific and technical information gained from federally supported programs (see p. 90).

In considering activities pursued by this Department in seeking new applications for scientific and technical findings, it is important to keep in mind the character of the farming industry which is a major, but by no means the only, focal point of this Department's effort. Application of much of the new knowledge related to agricultural production, processing, and distribution practices must extend to a high percentage of the Nation's individual farmers and distributors if its full impact is to be realized. This situation poses requirements uniquely different from transferring technology to one or a few major industrial concerns as would be true in many types of physical and engineering research findings from Government agencies serving other elements of the Nation's economy.

The description of the use of mass communications media and the comprehensive education and demonstration program of the extension service covers the principal procedures employed for transferring technology to agriculture's widely dispersed clientele.

For those parts of our research effort which normally find application in the private industrial sector, notably utilization, processing, and marketing research programs, it is the policy of the Department of Agriculture with regard to both inhouse and extramural programs to encourage and assist in the exploitation of technology resulting from such research. Many procedures are employed in transferring such new technology to industry. In the Forest Service new applications are actively pursued through technical, developmental, and functional divisions; memorandum of implementation; State and private forestry working with State and industrial foresters and with small forest industries and forest managers; periodic program reviews with national forest administration; regular meetings with representatives of forest industry; through individual and small group meetings with forest and forest industry representatives; and through response to individual inquiries by visit, telephone, and correspondence.

The four regional utilization research laboratories of the Agricultural Research Service hold an average of more than 50 industrial conferences annually to communicate research findings and applications to other scientific workers, and technical and industrial groups. Proceedings of the more important conferences are published. In addition, the laboratories each year receive an average of more than 7,000 technical visitors who observe research results and applications firsthand. Marketing research divisions cooperate extensively with the private sector in developing more effective techniques, layouts, and equipment, in the handling and distribution of farm and forest products.

The general practice of this Department in governing patentable results growing out of Federal research programs though public service patents assigned to the Secretary of Agriculture and made freely available under nonexclusive licenses to all applicants has, we believe, been the right policy for this Department, with advantages outweighing disadvantages. This policy has been sufficiently flexibile to permit effective collaboration with cooperators in colleges and universities, especially where substantial cost sharing is involved. Generally, the patent policies of those institutions are designed to protect the public interest and can be permitted full play in our cooperative agreements with them.

The Department generally has not secured foreign patents on its research findings of a patentable nature.

### 6. DEPARTMENT OF THE INTERIOR

All technological developments resulting from Office of Coal Research research projects are published in a final report which is then distributed publicly. Thus, the details of the technical developments so reported are available for the broadest possible acceptance and application. The Office of Coal Research does not pursue potential new applications resulting from such processes since we believe this would be beyond the province of our act once the research has been completed.

The Office of Saline Water research and development program is conducted through contracts and grants with private industry, universities and nonprofit institutions. In addition, OSW has several agreements with other Government agencies. Essentially all of the

work conducted by the Office of Saline Water under these arrangements results in the preparation and submission of reports on the technical data acquired during the performance of the OSW-sponsored work. These reports are reviewed by the cognizant technical manager and the reports are then prepared for issuance as OSW technical reports. These reports are distributed to other interested OSW contractors, as well as other governmental organizations. Periodically, OSW releases lists of recent OSW-published reports for the general public. These lists get widespread distribution and appear in many of the trade and technical journals.

In addition to the above procedure, the Office of Saline Water and contractor personnel representing OSW participate in technical symposia, as well as occasional international symposia related to the desalting field. Much valuable information regarding technological programs in the desalting field is gained from these meetings. The desalting field also has two newsletters, Desalting Digest and Water Desalination Report, which contribute greatly in focusing the many efforts and activities underway in this technical field. Both the Office of Saline Water and its contractors supply information to the editors and reporters of these trade newsletters in order to broaden the base of knowledge in the desalting field.

The Office of Saline Water personnel also participate on several intra- and inter-agency scientific and technical coordination groups in order to keep informed on the programs and developments of other Government-sponsored research. Since OSW is greatly interested in other Government-sponsored research programs concerned with water and its properties, as well as the materials research and development programs of several agencies, close contact is maintained with these other agencies both through these coordinating committees and systems as well as through personal contact.

The widespread dissemination of technical data concerned with the Office of Saline Water program, as discussed above, naturally leads to the evaluation by both OSW personnel as well as contractor personnel of the technology developed. Application of this new technology to the current development program is also explored and, where appropriate, new processes, materials, or operating techniques have developed.

### GEOLOGICAL SURVEY

With respect to (*a*), the results of surveys, investigations, and research are identified and reported by means of press releases; making new information available by placing copies in the open files where they may be inspected; rapid, simple publication as Geological Survey circulars; by the annual review of Geological Survey research, containing summaries of the most recent technological developments; annual bibliographies, two monthly abstract journals; monthly, annual, and cumulative lists of publications of the Geological Survey; lists of Survey publications by States; and index maps showing availability of Survey maps by States. In addition, the Survey maintains seven Public Inquiries Offices, stragetically located in different parts of the country, which provide the public with various services, including information concerning availability of scientific and techologic information.

With respect to (*b*), data and interpretations are critically reviewed and evaluated before publication is authorized. Publications are organized into logical series of topographic maps, hydrologic atlas sheets, geologic maps, water-supply papers, bulletins and professional papers, et cetera, so that potential users can more readily identify the type of material they desire. In addition, the indexes and bibliographies described in (*a*) above organize and cross-reference all maps and publications by subjects, by geographic areas and political divisions, and by authors.

With respect to (*c*), the results of the Geological Survey's surveys, investigations, and research are made public by the means described above to the maximum extent possible; only a small percentage of its work is classified for reasons of national security.

With respect to (*d*), the Geological Survey actively pursues technologic innovations in applying research and development findings to its own programs, and reports to the public for such applications. The existing evidence indicates that the private sector is quick to use or adapt the Survey's findings when these are economically beneficial.

(*a*) Pursuant to the authorities granted in Public Law 386, the Bureau of Mines prepares and publishes numerous reports for distribution to, and use by, the Department, other Federal agencies, State and local governments, and industry. These reports cover all aspects of the Bureau's health and safety activities, mineral and mineral fuels research, mineral resources investigations including economic, statistical, and commodity studies, and helium production and conservation programs. The principal Bureau publications are as follows:

(1) *Reports of investigation.*—These reports present the results of the Bureau's mining, metallurgical, coal, petroleum, helium, and health and safety research activities. They describe the principal features and results of minor investigations or phases or major investigations, thus keeping the mineral industries and the public advised on research progress.

(2) *Information circulars.*—These provide information regarding technological and engineering developments and activities in the mineral and mineral fuel industries.

(3) *Bulletins.*—These are comprehensive publications of longlasting interest which cover scientific, technological, and engineering investigations conducted by the Bureau.

(4) *Mineral industry surveys.*—The surveys are a variety of statistical and economic reports on trends in production, distribution, stocks, and consumption, of about 100 different mineral and mineral fuel commodities. The surveys also present data on accident statistics. These surveys, of which there are about 135, are published either monthly, quarterly, or annually, depending upon the type of survey or the mineral commodity involved.

(5) *Minerals yearbook.*—This four-volume compendium reviews the mineral industries in the United States and foreign countries; it contains official Government statistics on metals, minerals, and mineral products; and includes factual accounts of economic and technologic developments and trends.

(6) *Special and periodic reports.*—An example is Bulletin 630, Mineral Facts and Problems, which is published every 5 years. This is a one-volume encyclopedic reference work giving the geology,

mining, production, and use of various mineral and fuel commodities together with information about the industries based on these commodities.

(7) *Outside publications.*—These are articles by Bureau authors that are published in the technical press, in proceedings of meetings, and in books. During an average year, we publish about 250 such articles.

(*b*) The health and safety inspection, education and research programs, helium production and conservation activities, research investigations, and factfinding programs are under continuous surveillance and review by Bureau management. The effectiveness and utility of the information disseminated to the public and private sectors is determined by means of regular or periodic formal and informal inquiries and contacts. By these contacts, a determination can be made as to the use that is being made of the information which the Bureau produces, and what new or improved industrial developments result from the Bureau's research findings.

(*c*) The Bureau's publications are distributed to the public, private industrial sector, educational institutions, libraries, to other Federal agencies, and state and local governments, upon request. Some of the publications are for sale and others are free.

Regular canvasses of the mailing lists for each type of publication produced by the Bureau and review of the number of direct requests for the publications from the private community, as well as volume of sales of the Bureau's publications by the superintendent of Documents, determine the demand for and advisability of continuing publication of the information.

(*d*) The Bureau's immediate and long-range planning and programing activities are dedicated to channeling and directing our research and investigative efforts into those areas of study which can be characterized as in the national interest. The activities involve the proper and orderly application of scientific inquiry in the wise development and use of minerals and fuels in order to sustain the Nation's economic strength and to assure an adequate supply of mineral raw materials to meet the needs of an expanding population and constantly rising standard of living. The activities also involve the collection of timely, accurate, and vital information on mineral and fuel resources to enable industry and Government to make soundly based decisions on mineral policy and to provide a meaningful basis for intelligent planning and program operations.

### 7. FEDERAL AVIATION AGENCY

(*a*) During and after completion of FAA funded projects, periodic and final reports are required in identifying work performed and results obtained. In the case of intramural projects, they are prepared in accordance with FAA Handbook 1710.2, "Preparation, Documentation, and Release of Federal Aviation Agency Scientific and Technical Reports." Contractors are required to comply with specification FAA–D–2129, "Contractor Prepared Technical Reports," which is an integral part of all requests for proposal (RFP) and contracts where applicable.

(*b*) Research and development projects identified and approved at staff level are organized via program area in the FAA technical

program document, prepared annually and constantly updated, and assigned to program and project managers. In the case of contractual work, project managers serve as the contracting officer's technical representatives. In all cases, program and project managers constantly evaluate work in progress, and review for acceptance periodic and final reports.

(*c*) Reports are duplicated and distributed to FAA libraries, Defense Documentation Center (DDC), Clearinghouse for Federal Scientific and Technical Information, and the National Aeronautics and Space Administration. Their availability is announced via numerous media: biweekly FAA internal notices released agencywide periodic external information releases widely distributed through mailing lists and various symposiums; semimonthly abstract journal publications by the Clearinghouse "U.S. Government Research and Development Reports Abstract Journal for Science and Industry," the DDC, "Technical Abstract Bulletin," and the NASA "Scientific and Technical Aerospace Reports."

(*d*) No policies and procedures exist for the active pursuit of new applications in nonaviation areas for FAA-derived technology. This does not preclude the encouragement of such prusuit by technical program and project managers where opportunities present themselves. New applications are primarily derived by diligence on the part of industry in keeping aware of new developments through information media.

### 8. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

The agencies of HEW conduct a substantively and functionally wide range of activities, and employ a wide range of procedures and mechanisms for processing and disseminating the technology developed in these activities.

Publication in scientific and other journals is a traditional, and perhaps still remains the primary, method for making research and technological information available to the scientific and industrial community. The Department encourages such publication by its intramural researchers, grantees, and contractors. Beyond encouragement, the procedures used by HEW agencies for reviewing grant and contract proposals (e.g., study section peer group review) make it incumbent upon the applying investigator, as a practical matter, to make sure that his work is promptly made known to the scientific community.

More highly organized means for transferring technology are the information clearinghouses some of the agencies have formed or participate in for the exchange of scientific and technological information with other Government and private organizations. Further, while each HEW agency is largely responsible for transferring information about its own technology, the Department operates nine field offices which furnish technological information along with other less technical information about HEW programs.

The Department's overall policy favoring the widest availability of technology created with HEW funds and its specific concern that inventions resulting from activities it supports be promoted and used are reflected in its uniform policies regarding the administration of patents and inventions resulting from Department-supported research activities.

The Department's regulations regarding patents and inventions (45 CFR, subtitle A, pts. 6–8) recite the policy of the Department. This policy is generally implemented in the case of inventions by full publication of invention disclosures and by royalty free licensing on a nonexclusive basis of any patents covering such inventions. The regulations permit certain exceptions where the public interest in achieving the administration, development, and practical application of inventions can best be promoted through other means.

The Department requires that inventions by employees and with certain exceptions inventions resulting from research work under grants and contracts be reported promptly to the Department for disposition by the Assistant Secretary for Health and Scientific Affairs.

Consistent with the general policies outlined above, the Assistant Secretary's determinations generally require that ownership of inventions shall be in the United States and that the inventions be dedicated to the public by means of publication. Where an invention is of particular significance, the Department may patent it; in such cases, the patent is either dedicated to the public or licensed to all applicants on a royalty free, revocable, and nonexclusive basis.

Further comment on the separate parts of question 3 follows:

(*a*) The identification and reporting of research and developmental findings is insured by requiring that all grantees, contractors, and intramural researchers submit progress reports periodically. The supporting agencies also maintain direct contact with their investigators.

(*b*) The evaluation of reports, publications, and other papers which result from research and development activities is made by staff members of the agencies, by members of the scientific community acting as consultants, and by formal groups advisory to the agencies. The agencies are responsible for the organization of these findings. Most have developed computerized methods of data storage and retrieval. Much emphasis has been given recently to useful coding of subject matter so that a quick print-out of relevant data can be obtained on demand.

(*c*) Publication and dissemination are still in many cases the responsibility primarily of the researcher or developer. The specialized dissemination organizations and mechanisms discussed elsewhere in detail employ computer print-outs and distribute technical reports prepared by the agency staffs or by agency contractors.

HEW agencies use the Government Printing Office for distribution of many of their reports. They also supply reports to depository libraries and to HEW Regional Offices for reference or distribution. Technical reports are sent also to the Federal Clearinghouse for Scientific and Technical Information. Projects supported by the agencies are listed with the Science Information Exchange.

In addition, the agencies sponsor conferences and other formal opportunities for direct personal exchange of information.

(d) The active pursuit of new applications is left largely to the potential users, whether in other Government agencies or outside the Government. Secondary, or "spinoff," uses of technology are not, however, ignored by this Department. Agencies producing technology pursue new applications holding promise not only for performing their own missions, but also for the programs of organizations outside the Federal Government. One example is a program being

carried out by the National Communicable Disease Control Center for assisting State and private clinical laboratories in the modernization and improvement of their laboratory procedures. This Center collaborates in, and keeps a close watch on, investigations of improved and automated laboratory procedures underway at the National Institutes of Health and at a number of centers supported by the National Center for Chronic Disease Control with a view to transmitting applications to the State and private laboratories.

### E. A Uniform Government-wide Policy, Question 4

The agency replies present a variety of viewpoint on this subject. NASA, AEC, FAA, and some of the Department of the Interior Bureaus believe that the identification of new technology is the critical stage of the process in which the Government should be more involved. A policy to place responsibility on an R & D performing agency to process all of the significant scientific and technical information into a form ready for dissemination would require specific programs and budgets for this purpose.

The alternative suggested by the DOC is to concentrate on aiding business to identify needs by education and counseling programs. This view holds that the study of innovation will reveal new and improved ways for the Government to create a more hospitable climate for the entrepreneur who will then proceed to seek out the information he needs.

The DOD and USDA see little reason to generate a new policy, indicating their present practice is adequate (note similarity of wording, p. 142). Presumably, these agencies would not object to all others following their lead in a uniform manner.

The DHEW recognizes a need for all agencies to consider the interests of a public broader than that served by its own programs but believes that the diversity of technology would not be accounted for in a detailed uniform reporting system.

The replies of NASA, AEC, and DOC may be consistent because different phases of the process are considered. The agriculture and medical policies are for primary rather than secondary transfer. The Department of Defense reply is not consistent with any overt Government transfer effort.

A comprehensive policy could be synthesized from the agency positions as follows:

1. Agencies which generate technology in fields not common with commercial business (military, aerospace, nuclear weapons) could create special programs for identification and reporting of all new technology.
2. A single agency (perhaps the Department of Commerce or the Small Business Administration) could devise programs to aid industry in secondary utilization of technology.
3. Agencies which generate technology for direct primary utilization by industry (USDA, DI, DHEW) could continue successful transfer programs and participate in the Federal scientific information system.
4. All agencies could extend internal reporting efforts to cover more of the gray area technology between scientific reports and patents.

5. All agencies could increase their awareness of existing Government-controlled technology which could be of value to their own missions.

Selections from the agency replies are as follows:

1. NATIONAL AERONAUTICS AND SPACE AGENCY

No simple answer to this question exists. A Government-wide policy governing the use of such technology should ideally enunciate the basic objective of attempting to maximize the return on the Federal investment in research and development efforts by assuring the widest practical use of the new knowledge and new technology which is generated. A policy on this subject would necessarily involve all aspects of the transfer process—identification, screening, and evaluating, organizing for instant retrieval, publications, and repackaging, and dissemination—all done in such a way as to encourage its use.

Technology exists in many forms—in documents of many kinds, in not yet articulated concepts and understanding, and in physical devices and systems. The documents will appear in such diverse forms as patents, research reports, data not yet analyzed, handbooks, trade press articles, papers in technical journals, proceedings of conferences and seminars, scrawlings in the notebooks of scientists and engineers, and countless other forms.

The chances of finding it will not be good unless at least two conditions are met: (a) capable people are assigned, as their primary responsibility, the task of seeking it out, and (b) those who generate it—the practicing innovators and their supervisors—recognize the value of transferring the results of their work and agree to cooperate.

But more is required. Perhaps further steps toward a national policy encouraging the reporting of new technology (of an unclassified nature) would be helpful. And perhaps there is a need to analyze and more specifically define the conditions under which limitations should be placed on the communication of unclassified information. And Government agencies should continue to be encouraged to declassify documents at the earliest time consistent with national defense considerations. And, ideally, all agencies generating a significant amount of new technology might be encouraged to assign responsibilities for the identification of new technology to qualified and enthusiastic personnel.

The point was made in the January 10, 1963, report of the President's Science Advisory Committee, entitled "Science, Government, and Information:"

> Transfer of information is an inseparable part of research and development. All those concerned with research and development—individual scientists and engineers, industrial and academic research establishments, technical societies, Government agencies—must accept responsibility for the transfer of information in the same degree and spirit that they accept responsibility for research and development itself.

Only a relatively small portion of the new technology generated through Government R. & D. programs is evaluated for transfer purposes.

Perhaps the originator of new knowledge could be encouraged to make a judgment of its utility.

Clearly Government has a responsibility to make available the results of research and development performed by and for it when

the ready availability of such results would not tend to impair the national defense. The degree of Government responsibility in encouraging application of these results in the private sector is, of course, an undecided issue involving many complex considerations. Some of these questions have been mentioned in *Background, Guidelines, and Recommendations for Use in Assessing Effective Means of Channeling New Technologies in Promising Directions*, a report prepared for the National Commission on Technology, Automation, and Economic Progress by Richard L. Lesher and George J. Howick, which is already available to the committee. This issue is discussed in that report on pages 80–101 and pages 151–178.

### 2. DEPARTMENT OF COMMERCE

We assume that this question refers to a policy intended to encourage or improve the use of federally funded technology.

There is evidence that technology developed for one purpose has a low probability of application for another and different purpose. Thus, whereas it requires only about 10 professional man-years of commercial R. & D. to produce a commercially utilized patent, the best evidence is that it takes over 1,000 professional man-years of either inhouse or contract R. & D. work directed at a DOD or NASA need to produce a patent utilized in the commercial sector. Similarly, the DOD Hindsight study shows that a given effort invested in commercial R. & D. has more than an order of magnitude less likelihood of DOD utilization than the same effort invested in DOD oriented R. & D. When such transfers did occur (as in the transistor developments), an examination of the details reveals that it happened that the needs of industry almost exactly overlapped those of Defense. These examples are supported by many others.

Why this is so can be understood from an examination of the nature of the equipment-improvement observed in Defense. It was found that it was the synergistic effect of many innovations, often small in themselves, which together made big improvements possible. Thus, only if a particular innovation "fits in" with many others is it really useful. It is this fact which probably accounts in good part for the low utilization for one purpose of technology developed for an unrelated purpose. It is also for this reason that, when obviously significant "commercial fallout" of Government R. & D. does occur, it does not occur in fragments, but rather it comes in integrated packages. Thus, the B–52 and the KC–135 aircraft could be converted into the commercial 707 with a tolerable effort. Similarly, the original commercial digital computers were little more than a repackaging of the military and Census Bureau computers and the first commercial communication satellites were nearly identical to the NASA communications satellites. In all three cases, the needs of the Government and the private sector were very similar even with respect to performance, reliability and cost. Similarly, although the probability of the use of an expensive, high-performance titanium alloy in an automobile for example, is quite low, the same alloy is used commercially (in a turbojet engine) where it is an integrated part of a "transferred package."

Studies of the production rate of patents show that they too are primarily stimulated by recognized needs and market opportunities

for the equipment or processes into which they fit. Thus, although in recent years there has been little activity in railroad patents, the existence of new high-speed ground transportation programs and the potential market they promise to generate have produced a burst of innovative activity in the design and control of rail and other guided vehicles, many of which will appear as patents. If past experience is any guide, it is these new innovations which will be the primary source of the expected high performance of the new ground equipment.

Any Government policy in the area of technology utilization should be fully in accord with the principle: Need-recognition is the key to both the efficient generation of new, useful technology and the improved utilization of existing technology.

If the Federal Government wishes to most efficiently improve the operations of other Federal agencies or of industry by means of technology, it should:

(1) do everything in its power to assure that such agencies or private sector organizations have adequate motivation and funds first to identify and analyze needs and then to locate existing technology and to generate new technology;

(2) support programs that raise the ability of scientists and engineers in commerce and industry to acquire and apply new technology, and

(3) assure that all existing federally sponsored technology is reported, organized, and announced in the most efficient manner possible. Thus, potential users with needs can quickly, accurately, and easily find out what is in the Federal store, and make use of it if it fits their needs.

With respect to local need-identification and analysis, the private sector in item (1), and competent personnel in item (2), the State technical services program is highly relevant. Continued and expanded support of this program is desirable.

With respect to increasing the motivation of the private sector in the production of new technology, one of the most powerful governmental actions is to generate a market for such technology. This market can be stimulated by Government regulations (as in safety standards for automobiles), by Government procurement policies (as (as in the setting of performance standards for GSA building construction), a program initiated by the Institute for Applied Technology in cooperation with GSA, or by direct support of new private sector activities (such as new types of ships, ground transportation systems, etc.).

With respect to assuring that all federally sponsored technology is organized and available as in item (3) above, we believe that the existing DOC responsibility and capability to provide a central comprehensive source of information on all federally supported technology could be strengthened. New policies, or better implementation of existing policies, may be necessary to increase the degree of coverage of the clearinghouse for all unclassified federally supported technology and related economic studies.

With respect to further developing the Federal capability to understand and promote technology transfer of all types, we believe that the strengthening of the Institute for Applied Technology would be very appropriate, since this role is central to this organization, not

only in its operation of the clearinghouse, but also in its Office of Invention and Innovation, and in its concern with performance and other types of standards.

### 3. DEPARTMENT OF DEFENSE

We believe that current efforts through our existing information programs coupled with the scientific information activities of the Office of Science and Technology in the Executive Office of the President, the Department of Commerce and the National Science Foundation provide sufficient means to facilitate the secondary application of technology. Therefore, the Department of Defense does not believe that any additional Government-wide policies pertaining to the transfer of technology are required.

### 4. ATOMIC ENERGY COMMISSION

If the Federal Government should decide that in the interest of continued improvement of the general welfare it shall be the policy of the Government to actively promote the transfer of technology, then, some general policy for agency guidance is required. The basic question, however, is how comprehensive and detailed a statement of policy is needed, desirable, or feasible. We believe that the statement should indicate that (1) it shall be the policy of the Government to encourage the transfer of technology, and (2) the research and development agencies shall establish and budget for programs to promote the transfer of technology. It also will be necessary to define the type of service which the agencies may perform so as not to conflict with the services available from the private sector.

The establishment of a Government-wide transfer program will require additional expenditures by the agencies involved. If NASA's experience is typical, then the technology utilization program should cost only a very small fraction of 1 percent of the budget of the research and development agencies. The actual cost, of course, will depend on the role of the Federal Government in such a program. In question 5, we have defined this role, as we see it.

### 5. DEPARTMENT OF AGRICULTURE

A careful review of those procedures which have proven effective in the wide adoption of new technology generated by our research and development programs leads this Department to conclude that it would be unpractical and unwise to establish a uniform Government-wide policy governing the use of such technology.

We believe that current efforts through existing agricultural information programs, coupled with the scientific information activities of the Office of Science and Technology and the National Science Foundation, provide adequate means to facilitate the application of agricultural technology. Technology developed by all agencies of the Federal Government, except that of a classified nature from defense and security agencies, should be available to all citizens of the United States. As a corollary, prompt publication of primary research results in all nonsecurity areas should also be Government-wide policy. In this way, private enterprise could, and in many ways

would, use these primary results as a basis for development of technology.

This Department's view of the need, desirability, and practicability of establishing a uniform, Government-wide policy coincide with those set forth in the Presidential Memorandum and Statement of Government Patent Policy, issued October 10, 1963. In general, it is our position, that to the extent possible, it is consistent with the public interest that a uniform policy be followed in which technology resulting from research financed by public funds be made freely available to the public.

The Department's views in this area are set forth in the attached statements contained in the reports from the Secretary of Agriculture to the chairman of the Senate Committee on the Judiciary, on three separate bills before the 89th Congress.

### 6. DEPARTMENT OF THE INTERIOR

The Department of the Interior follows a policy of making its Government-sponsored technology (except that very small portion related to defense and national security) available to the public as rapidly as possible and assuring that it is clearly presented for ease in interpretation and effective use. We would support the Government-wide extension of such a policy.

It would appear at this time that sufficient organizations already exist within the Government to perform the necessary services to insure use of the technology which emerges from Government contracts (i.e., U.S. Patent Office, Commerce Clearinghouse on Scientific and Technical Information, and COSATI).

The results of FWPCA efforts are already widely disseminated and plans to increase the degree of dissemination have been developed. Mechanisms for the utilization of technology developed as a result of FWPCA supported programs by Federal, State, municipal and other public or private agencies have been established as described under question 6 below. To what extent other Government agencies have set up similar dissemination and utilization systems is not known to us. Therefore a uniform Government-wide policy might be desirable provided it did not seriously delay the dissemination of new technology.

The Bureau of Mines believes that the missions and charters under which the different agencies and their respective bureaus operate are so diverse that it would be undesirable and, indeed, impractical to establish a uniform Government-wide policy governing the use of technology transfer. It seems unlikely that a common ground for establishing a uniform policy could be found, particularly when one considers, for example, the different goals and objectives of the Forest Service, Department of Agriculture; the National Bureau of Standards, Department of Commerce; and the Bureau of Mines.

The Bonneville Power Administration recognizes the need for the establishment of a uniform Government-wide policy for making possible transfer of technologies developed in Federal agencies by way of "in-house" research or as a result of research and development contracts to all other Federal agencies as well as to State and local governments and to the private industrial sector.

At the present time, with the exception of extremely well informed specialists and experts, it is nearly impossible for Government technologists to determine and ascertain the results of all Government-wide Federal research taking into consideration that there is no centralized or computerized system for locating new technology. However, a well established library reference service can provide a high degree of selective dissemination of information. Such a system has been established at the Bonneville Power Administration.

The Bonneville Power Administration does not know whether the Department of Commerce Institute for Applied Technology which was established for the purpose of a centralized clearinghouse for Federal scientific and technological information has been able to computerize the new technology which has resulted from Government research projects so that governmental agencies, instititutions, and the private sector could be aware of research projects underway and completed, and the results thereof as well as keeping up with future Government research effort.

Both Government and industry have been struggling for a long time with the problems associated with the dissemination and application of technical data derived from research and development programs so that maximum use is put to the technology that has been developed and so that unnecessary duplication does not occur in related research and development programs. Experience, I believe, has proven that this problem of technology distribution and utilization is a difficult one and has no easy solution.

With regard to the need, desirability, and practicality of establishing a uniform Government-wide policy for the utilization of technology growing from Government-supported research and development work, it is important to consider the great diversity in situations existing within various agencies and offices. In offices such as the Office of Saline Water, the requirement for complete dissemination already exists, while in other offices there is no responsibility for dissemination, and such dissemination as may be made depends entirely upon initiative taken outside the Government. It would perhaps be desirable as an intermediate step to establish a uniform responsibility for dissemination within each agency before proceeding with a separate Government organization having responsibility to control such dissemination. Activities already underway, such as the Department of the Interior Water Resources Information Center now being implemented, will achieve effective access to all data in this field. This establishment of such centers for all major areas of interest should make available to industry and small business Government technology in an efficient and useful manner, especially if such information centers are intertied.

It is quite possible that an effort to establish a separate organization responsible for dissemination and application of technical data may serve to restrict or delay such dissemination and application by injecting an intermediary between the source and the public.

If question (4) is interpreted to mean "* * * establishing a uniform, Government-wide policy governing the *transfer of information on* such technology," our viewpoint would be that it is both necessary and desirable to establish a uniform, Government-wide policy on transfer of information. Such elements of information that concern cataloging, indexing, and abstracting appear to be most susceptible at this

time to standardization, and the ease with which they can be standardized will diminish as individual information systems proliferate. In terms of practicality, this proliferation and the forthcoming expanded use of information science are forces which point to the need for standardizing other elements at an early date so as to avoid having to deal in the future with too many diverse techniques and systems.

The American Documentation Institute calls 1966 the "coming-of-age" year for information science, and surely in this time span of 21 years the practitioners cannot be expected to have developed seasoned methods for handling the information explosion that began with the invention of the printing press in the year 1430. Both software and hardware applications to information problems are developing too rapidly for adequate assessment of these techniques. In addition, what is thought by some to be an area of research thus far sadly neglected—that of studying the interaction of user with information—is hardly out of the embryonic stage, and there are no demonstrated principles upon which reliance can be placed in the design of current awareness and retrieval programs. Furthermore, it can be stated with certainty that the design of systems must recognize the differences in types of information to be processed. For example, the field of chemistry, with its infinite compounds and classes thereof, must be handled differently than most engineering fields.

In summary, we take the view at this time that the only real uniformity in policy which can be established is that which endorses the absolute necessity to transfer information. The present practicality of achieving uniformity in most facets of information transfer transfer operations is doubtful.

### 7. FEDERAL AVIATION AGENCY

From the viewpoint of this Agency, a uniform, Government-wide policy governing the use of such technology appears useful. This does not imply that the Federal Government should in any way inhibit the responsibility traditionally inherent in the private sector, the application of industrial research. The role of the Federal Government should be confined to the application of research and technology directly derived from national programs such as space, atomic energy, and defense where it by necessity retains the greatest proportion of activity. COSATI has already made progress in the direction of centralized uniform methodology for handling Government-derived technical information. This Agency is actively participating with COSATI in this effort.

### 8. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

A uniform, Government-wide policy for handling technology created with the support of Government agencies is desirable so long, and only so long, as it is limited to broad principles, such as maximum availability to the public of Government-produced scientific information and technology, design of information systems and programs to enhance the effectiveness of mission accomplishing programs, the duty of each agency to coordinate its information distribution efforts with those of other agencies, and the responsibility of each agency to consider the interests of a broader public than that regularly served by its

own programs. These broad principles must, of course, be subject to such limitations as national security, the protection of confidential disclosures, reasonableness of demand on administrative resources of the agency, and the like. Imaginative, individualized programs should receive encouragement.

This Department strongly opposes, however, any Government-wide policy which would seek to establish uniformity for all Government agencies as to the types of information to be processed and disseminated, the procedures and mechanisms for doing so, the user groups to be served, and so forth. To try to impose detailed uniformity upon the multiplicity and diversity of mission, character of scientific and technological information, and class and need of program beneficiary represented by all Government and private agencies would have a number of foreseeable detrimental effects. Among them, agency resources and funds would be wasted on low value activities in some cases; n others, useful mechanisms and areas of intelligence would be passed by. Further, pressures toward uniformity would lessen chances of innovative action, and would simultaneously discourage imaginative and energetic people.

### F. A Centralized Organization, Question 5

Most of the agencies oppose the creation of a centralized technology processing and transfer program. The information storage and retrieval phase does have some support for interagency, common usage. (See DOC suggestion of a National Library for Science and Technology.) Even here, the concept of a number of specialized information centers separately located is preferred by the Department of Defense and others. The single contact point for users, whether other agencies or industry, is suggested. The Small Business Administration believes that practical commercial applicability is what must be disseminated, not merely technology.

The arguments against a centralized program deal with the diversity in both the identification and utilization phases of the process. Identification must be done locally at the point of origin and each agency professes to be the most efficient means of accomplishing this task. Dissemination and aid in application also require local, special purpose activities at the point of use.

The DHEW opposes even a centralized technology handling organization for itself because of the diversity and specialized nature of the information and user needs.

One viewpoint of technology transfer holds that the user may need to verify certain information by direct contact with the originator. Thus a centralized program inserts an additional filter or barrier to person-to-person consultation. On the other hand, industry is confused and the process complicated if it must deal with each agency individually to get the bits and pieces of technology for a project.

Selections from agency replies are as follows:

#### 1. National Aeronautics and Space Agency

Technology transfer is the use of technology developed for one purpose to fulfill a need elsewhere. It requires: (1) The knowledge that an advance has occurred in one field, (2) the recognition of its

significance in a different field, and (3) the capability to make the required adaptations.

The effective channeling of new technologies, then, demands more than document dissemination—and even more than communication of information from one point to another. For the assumption is that knowledge will not only be transferred—it will be utilized. And the process, it is hoped, will take place over a short timespan with resulting significant benefits.

Technology transfer takes place through normal educational channels, through conferences and seminars, through the trade, popular and professional press, and through a host of other means. No one transfer approach will be suitable for technology of such variety.

A national system for technology transfer which would contribute to innovation must include institutions and procedures suited to the variety of functions for which the technologist uses technical information. Resources should be available to assist in answering specific questions in relation to already perceived problems. Furthermore, other mechanisms should serve to stimulate new ideas, to help identify latent needs, to help assign research priorities, to keep engineers up to date, and to confirm or deny tentatively held propositions. Such a system might best retain the pluralistic character of our present situation, while devising better means of switching a potential user to the several technology banks relevant to his immediate requirements. The statutory base of the Office of State Technical Services would seem adequate to perform this function.

Effective, systematized transfer of technology can involve a multiplicity of steps, each critical to the process. These might include:

Identifying the technology.

Screening out that which has current relevance for possible special emphasis—but not abandoning what remains (for it may have unrecognized value).

Documenting underlying concepts and principles as well as describing the discrete advance.

Organizing the technology or information in a manner that permits its retrieval for a variety of potential users—with different languages, interests, and orientations—in a rapid and efficient manner.

Bringing relevant parts of it, on a selective basis, to the attention of a variety of potential users.

Arranging for seemingly unrelated pieces, originating in separated areas, to be fitted together.

Relating it to ongoing efforts that may enhance its value.

Organizing it in such a manner that it not only can be called out to meet specific defined needs—but also so that it can be a source of ideas to the technical man who will "browse" through it.

Permit the full inventory to be examined in such a way as to allow the discovery of areas of knowledge convergency or potential breakthrough areas, and areas of need.

And all of this must take place in an economic and social environment conducive to change.

Clearly some of these responsibilities cannot be separated from the site of generation of the knowledge. For both effectiveness and efficiency, the originator of new knowledge must identify, document, and report it.

Some portions of the activity might be centralized, provided a sufficient number of output mechanisms to meet the multiplicity of requirements of a wide range of users would be made available.

Much additional research and experimentation also seems required before any specific mechanisms might be determined to be the most effective and efficient set to employ. Perhaps, at present, a national network of systems might be more useful than a single national system. This implies the development and implementation of more effective approaches to and techniques for coupling and switching than are presently generally available to the user. Regional Dissemination Centers supported by NASA, institutions operating under the responsibility of the State Technical Services program, and the Offices of Industrial Cooperation at Atomic Energy Commission laboratories along with some specialized information centers, the trade press, trade association, and professional societies presently perform some coupling and switching functions.

### 2. DEPARTMENT OF COMMERCE

As we have stated above, we believe it is both inefficient and unnecessary to try to "push" federally supported technology on to other agencies or on to the private sector, and we are, therefore, opposed to the idea of central organization with this mission. There is some other evidence to support this opinion. For example, experiments in the United Kingdom with such an organization have not been encouraging, and the Research Corp., which seeks to market university patents (which as for Government technology are almost always isolated ideas), has not been particularly successful, even though it offers exclusive patent rights to the user (which the Government usually cannot do).

There is, however, one concept of a new central organization that might be worth consideration, and that is a National Library for Science and Technology. This would be similar to, and complement, the present National Libraries for Medicine and Agriculture. Such a library would store and announce, as appropriate, all the available technical literature in the physical sciences and engineering, including the Federal contributions. It would have an expert research and referral service, with the aim of directing inquiries to other appropriate private and public information centers. It would provide hard copy or microfiche copy of reports and articles as is now being done by the clearinghouse. It would provide an ideal central contact point for all users with specific technical needs. Its services would be of great value to both Federal agencies and private organizations.

### 3. DEPARTMENT OF DEFENSE

Based on our experience in DOD it is not clear that the establishment of a centralized organization for handling all phases of technology transfer is warranted. In the absence of a clearly enunciated plan, demonstrating the cost benefits of such a system, DOD has no basis for opposing or supporting a more centralized system. However, we believe that a decentralized system is more effective.

It may be desirable to centralize all Government scientific and technical information portions of the technology transfer process to the private industrial sector primarily to provide a single point of

contact for private industries. Any additional technology transfer efforts in behalf of private industries by a central organization should be considered in relation to the benefits to be gained.

### 4. ATOMIC ENERGY COMMISSION

In our opinion, the establishment of a central organization to handle all phases of a technology transfer program is not feasible. Perhaps a brief review of the processes involved in accomplishing a transfer of technology will clarify the reasoning behing this opinion.

The steps involved in the transfer process include the following:

1. The first step in the transfer process is the identification of innovations and the preparation of industrially oriented announcements. This step can be accomplished only by the issuing agency since both a thorough knowledge of the programs and close coordination with the innovator are required.

2. It is not necessarily true that all of the innovations identified by the agencies have potential use in industry. Some organization having a technically competent staff which has a close association with industry can provide the necessary evaluation. It would appear that some of the State agencies would have this capability.

3. Once the items are selected, the announcements of them must be printed and distributed. A central organization could provide this function.

4. The announcement of innovations, of itself, will not bring about any substantial transfer of technology, particularly to small business. What is needed is a local organization which knows the industry in an area and has a knowledge of the sources of information and assistance in the Government research and development agencies. It would seem that the designated State agencies could fill this role. One of the key factors in transferring technology is face-to-face communication and the State agencies could carry out the vital function of establishing communication among all interested parties. This is not to say that a central organization such as the Office of State Technical Services should not provide overall direction and coordination.

5. Once a company has decided to further investigate the use of an innovation, it requires additional information. A central organization could handle the dissemination of reports, engineering drawings, and references to commercial publications but the company also may need to talk to the innovator, to see equipment in operation, and to discuss patent or licensing matters. While the central organization through the State agencies could arrange for the contacts, only the innovating organization can effectively carry out this direct transfer of knowledge.

6. Finally, if a company decides to actively pursue the use of an innovation, a considerable amount of effort and funds may be required to convert the development for commercial use: additional research and development, engineering, market research, tooling and manufacturing startup. The Government already is providing assistance in some of these areas through programs such as those of the Small Business Administration.

A central agency could perform certain other functions such as:

1. Conduct studies of the transfer process and of transfer mechanisms.
2. Obtain feedback to determine the extent of technology transfer and why transfers did not occur.
3. Assist in educating the State agencies on the variety and extent of the Government services available to industry.

Perhaps what we are suggesting (in our response to question 5) is the establishment of a system modeled somewhat after the Federal Extension Service of the U.S. Department of Agriculture. The basic components for an industrial extension service seem to be available as a result of existing Federal programs and through the proposed activities of the designated State agencies.

In our judgment this industrial extension service should actively participate in all of the functions required to transfer the results of Government sponsored research and development to industry.

The central organization, such as the Office of State Technical Services, could provide overall policy direction and guidance, control the distribution of Federal funds to the State agencies, monitor the State programs and assist in developing effective transfer techniques.

Historically, the universities have not provided much direct assistance to industry but with the location of the State agencies at universities, they would seem to be the logical entities to serve as the interface between industry and the Government. With the wide range of knowledge at a university, the professional staff also could assist industry in such areas as marketing, business administration, engineering and finance.

### 5. DEPARTMENT OF AGRICULTURE

The Department of Agriculture opposes the establishment of centralized organization for handling all phases of technology transfer. In our judgment, the establishment of such a combined centralized organization would slow down the handling of the transfer of technology. Insofar as such centralized organization might involve centralized inventions administration, our views as to why this would be undesirable are expressed in the above noted reports on bills which were considered by the 89th Congress.

This Department and its cooperators through procedures in use effectively and quickly reach consumers, the action agencies, industries, and farmer users of agricultural technology developed through Department-supported research.

An information net with centralized access to information about available technology could supplement the Department's activities and those of its cooperators.

The use of the extension service as an educational and demonstrational arm of an agency's science and technology programs has proven to be an effective procedure in agriculture. There would appear to be opportunity to expand the use of this technique on a coordinated interdepartmental basis.

### 6. DEPARTMENT OF THE INTERIOR

We do not believe that a single centralized organization for "handling all phases of such technology" is desirable or practicable, because

of the quantity of research and the diversity of the technical fields involved. On the other hand, this Department cooperates fully with the Department of Commerce's Clearinghouse for Scientific and Technical Information in the dissemination of published research results; with the Library of Congress National Referral Center for Science and Technology in establishing direct contacts between anyone with a technical problem and the technical resources most likely to assist him; and with the Smithsonian Institution's Science Information Exchange in distributing information on research in progress. We would support every effort to give wider publicity to these very useful services.

The reclamation viewpoint is that establishment of a combined, centralized organization to handle all phases of *all* technology transfer operations would be very difficult, but that centralized information transfer technology could be applied to individual fields.

To illustrate the magnitude of a centralized operation, consider the Soviet experiment with centralizing translation, one phase of information activity. Some 2,200 persons are employed in scanning, evaluating, and translating activities in a single organization. If the other phases of dissemination and retrieval were added, and supporting personnel considered, the resulting organizational giant could become very unwieldy and quite costly.

We endorse the responsible-agent concept which has evolved from deliberations within the Office of Science and Technology. Under this concept, that agency having scientific and technical capability in the given field would be responsible for all governmental information activities in the field and would serve all agencies having parallel interests. While we realize that this is centralization to a degree, it is not combined centralization, and thus information transfer technology can be developed individually around the different requirements of separate fields.

*Bureau of Mines*

The Bureau has had no difficulty in transferring technology programs to other Federal agencies or the private sector. The success of the Bureau's transfer program is attributed to the variety of Bureau technical reports made available in the technical press and in the Bureau of Mines publication series. The publication and information dissemination program is implemented further through contacts and meetings of Bureau technical and scientific personnel with responsible representatives of the educational and industrial community. The Bureau's personnel also are members of and participate actively in professional societies through which media information pertaining to the Bureau's work is disseminated. In addition, representatives of the industry and the public at large frequently visit the Bureau's facilities which are strategically located nationwide.

For the reasons cited above, we do not believe that establishment of a central organization to transfer technology programs would be particularly beneficial to the Bureau of Mines. However, we see no objection to establishing such an organization. It probably would have certain advantages, one of which would be a wider dissemination and distribution of information pertaining to the broad spectrum of Federal research.

### 7. FEDERAL AVIATION AGENCY

In order to carry out a national policy with regard to the dissemination of new technology, it follows that a combined, centralized organization would be required. But it should be confined to only that responsibility necessary to carry out a national policy—not to implement it. The role of the central office should be confined to monitoring the operation of the service. The centralized organization should be established based on recognition of the magnitude and diversity of technological information generated. The necessary functions of collecting, storing, and disseminating information, because of this magnitude and diversity, would best be performed by a system of data banks functioning within the primary data-producing organizations but operated under Government-wide standards established by the central organization. Data bank information could be made available to any requestor—organization or individual. The Federal Government would serve as a centralized "brokerage" facility with individual branches operating independently within their respective disciplines.

### 8. SMALL BUSINESS ADMINISTRATION

I believe that, potentially, considerable benefits to industrial growth of small business are available from the accumulation of federally sponsored research and development information. This realization of potential, however, requires considerable new effort, for the present method of storing research data in the warehouses of the Federal Government, and of the various organizations which are participating in existing programs, is inadequate for the purpose intended. Hence, a means must be devised to achieve not only a transfer of know-how from the Federal storehouses to State and State-connected storehouses, as is being done now, but also an effective transfer of "how to use" the know-how.

This is not to say, of course, that what is being done is nonproductive. Our universities are rapidly becoming growing research centers, and are constantly engaged in valuable scientific studies. If the Government-stored information is efficiently assembled and compiled in the universities' research centers or State clearinghouses—as it is now being done with the means provided under the State Technical Services Act—the physical proximity thereof will enable their more expeditious use by the researchers. But, this does not fully serve the purpose which the act is intended to serve; namely, not mere *dissemination* of papers, but *utilization* of what they contain.

The real crux of the matter is, therefore, that the majority of small business organizations are facing an insurmountable problem of recruiting and supporting highly qualified staffs to decode the contents of the papers, which are becoming more and more locally available, and, after decoding, to know how to make commercial application, if any, of the decoded material. It is to cater to this specific need that the State Technical Services Act should be utilized. Since small companies cannot afford the time, energy, and finances to do that decoding themselves, the financial assistance provided under the State Technical Services Act should also be used for the purpose of determining whether or not the technical information therein can be put to

practical commercial use by small business. In other words, feedback of commercial applicability of accumulated research reports and findings to specific industry segments is essential. If this is clearly understood, small companies will be benefited by Government-funded research—and this is what, in our opinion, the State Technical Services Act means by "dissemination"—dissemination of practical commercial applicability, and not just mere dissemination of scientific papers.

### 9. THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

This Department opposes establishment of a centralized organization to handle all phases of technology acquired by the Department—let alone to handle the technological information acquired by all Government agencies—for the present, and at least until understanding of information transfer problems and methods for solving them have progressed much further. First, we do not think that development of information handling organizations, procedures, programing technology, and hardware has yet progressed to the point where such a comprehensive, centralized operation would be productive and efficient. We also question whether the technical and managerial manpower is available for such an operation today. Beyond current availability of resources, we have severe doubts as to whether an organization with such comprehensive responsibility would ever provide service to its many publics at least cost, or even acceptable cost. A related problem is that the personnel of such an organization would require subject matter as well as functional expertise; they would need to keep up with subject matter developments of agencies in which they did not otherwise participate, and with which they would necessarily have a less intimate acquaintance than would regular personnel of the agency.

Further, in line with our answer to question 4 on policy uniformity, organizational unity for the information transfer function would also tend to eliminate diverse and innovative handling of information. And the single agency would be unlikely to continue the present quality of service to certain classes of Government agency clientele being well served today.

A central coordinating body, however, offers immediate prospects for improvement at a comparatively small investment in personnel and financial resources and with low risk of disrupting existing services. It offers the prospect of encouraging identity in terminology and information categories, of cutting out unproductive duplication in the programs of the several agencies, of identifying and filling significant gaps in information programs, of encouraging cooperative division of effort among State and private sector activities, and generally, of rationalizing the entire corpus of national information handling activities. Such an organization could profitably be authorized to conduct the research, experimental activities, and demonstrations—especially those cutting across agency lines—which would provide the guides for future action. It could act as an information center on information systems and technology, serving both Government and private organizations engaged in information handling. And it could catalog information on the capabilities and services of existing information systems for the benefit of public and private consumers.

## G. Joint Federal-Private or Federal-State Dissemination and Transfer Concepts, Question 6

The idea of chartering a special corporation whereby private funds exploit publicly owned technology is exemplified by the Communications Satellite Corp. An analogous organization might be used to handle scientific and technical information and technology transfer. Most agencies (with the notable exception of the Small Business Administration) rejected this suggestion for much the same reasons they opposed a centralized Government operation. The AEC felt that the Government should not expand its role in converting innovation to commercial use but that a Comsat type of institution could be of service.

The other concept on which the subcommittee solicited comment is essentially that embodied in the State Technical Services Act. With the exception of some reservations by the DOD and DI, all agencies believed there was merit in this approach. The DHEW noted that special functionally designed regions might be more appropriate than State boundaries for technology transfer centers.

Excerpts from the replies are quoted below. NASA's comments were included in question 5.

### 1. DEPARTMENT OF COMMERCE

With respect to 6(a), we can only reemphasize our position stated in response to questions 4 and 5, which is that the Federal Government should not seek to establish such an organization, but rather it should:

(a) generate policies which help the private sector organizations in the identification and analysis of their own needs, and in the coupling of such needs into the Federal store, and

(b) collect all the Federal technology information in one place where it is organized and accessible.

With respect to question 6(b), we must observe that the concept is substantially identical to the State technical services program. We believe that by expanding this program at an appropriate rate and by increasing the coverage and referral services of the Clearinghouse, the mechanism of the technology transfer concept of 6(b) is in hand.

### 2. DEPARTMENT OF DEFENSE

The Department of Defense is unable to provide comments on the suggested concepts for Government-private sector technology transfer since we feel that the worth of formal technology transfer mechanisms must be evaluated in relation to the type of technology to be transferred and the benefits to the intended recipients. For Defense-developed technology, the Department of Defense procedures previously enumerated are considered sufficient for effective technology transfer.

We do recognize that in certain cases such as nuclear power and orbital communications systems, Government assistance may be required in the public interest to fully exploit available technology on a timely basis.

### 3. ATOMIC ENERGY COMMISSION

The final process in the transfer chain involves the conversion of an innovation to commercial use. The activities in this process include additional research and development, engineering, tooling, manufacturing startup, market research and the financing of these activities. It is our opinion that the Federal Government should not take any more active a role in these conversion activities than it now takes through the existing Federal programs such as those of the Small Business Administration.

It would seem that a COMSAT-type organization could perform this role particularly if it consisted of a consortium of consulting and management firms, privately established research and development firms, private institutions and the universities, including their satellite research organizations. Such an organization could provide not only the physical facilities but also the professional staff needed in the conversion process.

In summary we have tried to suggest what we believe is the proper role of the Federal Government in the transfer process. In our opinion the Government should participate in those activities which are necessary to insure that industry is capable of exploiting an innovation. The private sector should, in our judgment, provide those activities required to convert the innovation to commercial use.

### 4. DEPARTMENT OF AGRICULTURE

(a) This Department seriously questions the feasibility of a legislatively chartered "COMSAT"-type corporation to use private financing for the exploitation of the type of technology flowing from our programs.

Few of the scientific advances based on agricultural research are federally owned since most are fully disclosed to the public through publications. Patented processes assigned to the Secretary of Agriculture are freely licensed on a nonexclusive basis. In general, there is not a need for subsidized exploitations. While recognizing that some technological advances are of such magnitude and complexity as to warrant the COMSAT-type approach, we believe that the procedures involved generally would not hasten the adoption of new technology in agriculture.

(b) Individual State programs of the extension service type partially funded by the Federal Government, have proven their usefulness in the dissemination and application activity. We endorse this approach. Other types of State programs such as university research foundations may or may not be fully compatible with Federal objectives in hastening the exploitation of new technology stemming from Federal programs.

### 5. DEPARTMENT OF THE INTERIOR

Our disagreement with the concept of a single centralized organization for handling all phases of technology also applies to a COMSAT-type corporation and to "one unified Federal collection and processing organization" in connection with individual State programs. However, the State technical service programs authorized by Public Law 89–182 seem to serve the purpose envisaged by your question 6(b).

### 6. FEDERAL AVIATION AGENCY

It is conceivable that either of the two options suggested in your letter could perform the function of technology transfer successfully. Based on comments expressed on the preceding two questions, however, we endorse the second, a system of Federal collection and processing data banks available for information and advisory service to the individual State organizations already functioning under the State technical Services Act of 1965. It is logical to consider that the individual States are intimately acquainted with the industrial capacities available within their borders. They are in a position to expertly analyze the nature and extent of technological applications suited to the industrial forces available to them. With such a broad structure of organization already in being, the practical point of view dictates that it be used for this purpose.

### 7. SMALL BUSINESS ADMINISTRATION

We are greatly interested in the approach mentioned in the subcommittee's report in the Congressional Record of October 17, 1966, namely, the organization of a federally chartered COMSAT-like corporation. We have followed for a long time with great interest the activities of a British quasi-governmental agency, the National Research Development Corp. (NRDC), which is designed to accomplish the same ends as the COMSAT-like corporation envisaged by the subcommittee. NRDC's purposes are, essentially, to secure the use in industry of the inventive results of research paid for, or contributed by use of Government funds, and of other inventive results of public importance which have, as yet, not been developed and exploited. The functions of this organization are laid down in the British Development of Inventions Act, 1948, as amended, with which the subcommittee is undoubtedly familiar.

### 8. THE DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

This Department prefers reserving judgment on the general concept of a privately financed, federally chartered corporation to exploit federally owned or created technology. We do offer comments on the type of concrete proposal which might be found attractive.

The proposal should reflect comprehensive analysis of prior similar or related governmental and private operations, and furnish convincing evidence of the potential benefits of the service to be provided, prospects for adequate revenue, and so forth. The proposed corporation's powers should be carefully delineated. The programs authorized should be precisely stated, and the financing permitted should, at least initially, be limited to a modest figure. The corporation should be self-sustaining, generating both its own initial capital and sufficient revenues to cover its operating expenses. It should be required to reimburse fully any Government agencies it is authorized to call upon for any assistance beyond that which would otherwise be made available to an individual or organization in the private sector. It should in no event be permitted to overload the personnel or other resources of Government agencies. It should be given no "captive" customers, either in or out of the Federal Government. In other words, it should from the beginning stand or fall on its own merits.

Depending on such variables as the technological subject matter to be handled, the corporation should make its services equally useable and available to all segments of the business community (both large and small businesses) and to nonprofit organizations and non-Federal Government agencies.

Subject to the foregoing limitations, this Department endorses further investigation of the "Comsat" type corporation concept, and would probably favor a pilot project limited to a single, specific area of technology. The Department's position on such a proposal would be based, in any event, on its analysis of the detailed, concrete terms of the proposal.

The proposal for a unified Federal technological information collection and processing agency (function (*b*) and perhaps part of function (*a*) of question 3) coupled to 50 independent State agencies performing dissemination and application functions (functions (*c*) and (*d*) of question 3) has many of the disadvantages of the centralized organization proposed in question 5. It has additional disadvantages: in substituting 50 agencies for one, it would eliminate the economies of scale which are possible in certain types of publishing and dissemination activities; it would require expertise in 50 organizations to select technological developments warranting pursuit of new applications; and in most cases it would interpose a new bureaucratic layer (State agencies) between the technology creating agency and ultimate users.

There may be cases in which State agencies are better able, by reason of their acquaintance with local needs, to identify the categories of information suitable for local dissemination, the developments which are particularly promising, and the audiences to inform. But the limited number and value of such cases is suggested by the fact that the programs of industry, private service organizations, education and other non-Government parts of our society are not usually organized on the basis of State geographical boundaries. It is worth noting that many Federal Government programs administered on a geographical basis are conducted through special functionally designed regions rather than according to State boundaries.

State administered technological information projects do provide a mechanism for starting with a locally experienced need or problem to try to find a technological development to solve it. The State Technological Services Act of 1965 appears to offer the States such an opportunity to try to find help for local problems from Federal sources, including Federal technology; this effort deserves sympathetic observation. How productively this program works should indicate the value of participation by State governments in the technology transfer process.

## XI. ANALYSIS OF CONTRACTOR REPLIES TO QUESTIONS ON TECHNOLOGY TRANSFER

In December 1966, the subcommittee sent letters to 17 large industrial corporations which are principal R. & D. contractors for Federal agencies, soliciting their views on:

1. The general subject of technology transfer.
2. Present and projected Federal policies involving technology utilization.
3. Operation and effectiveness of present Federal programs whose objective is technology transfer.

Specifically five key questions were asked in order to obtain information to prepare the subcommittee to define a public policy with respect to the Federal role in technology transfer. These questions were:

1. What responsibilities (contractual or otherwise) do you recognize for the identification and reporting of new technology acquired under Government contract?
2. Do you have special mechanisms (outside of normal communications channels) for transferring technology among departments, laboratories, or locations within your own organization?
3. What are your views on requiring contractors to report new technology? What proprietary and patent ownership problems arise from such a requirement?
4. Please comment on any participation in existing Federal agency technology utilizations, either as a supplier of information or a user. What are the significant opportunities and weaknesses in these programs?
5. What are your views on a joint Government and private sector organization to exploit federally controlled scientific knowledge?

The replies are analyzed for each question and excerpts of significance are reproduced below.

### A. Responsibilities for Reporting New Technology, Question 1

The answers indicated a clear acceptance of the responsibilities contractually imposed to report new technology. Specific reports are made on inventions and innovations of patentable character and on the technical work done in the course of the contract. NASA's "new technology" reporting requirements were particularly singled out as going beyond the normal requirements of other Government agencies. The corporations assigned varying degrees of importance to this responsibility. Some viewed this function as a primary element of the R. & D. process and have given this responsibility to specific units within their organization. Others supplemented reporting with working level discussions between engineering, program management, and Government technical personnel.

Conversely, one corporation complained of the considerable time and effort involved that otherwise might be applied to the prime purpose of the contract. It can be inferred that any expansion of reporting requirements might meet with resistance from those who saw this as a lesser responsibility.

EXCERPTS

### Aerojet General Corp.:

We identify and report new technology acquired under Government contract by way of invention disclosure reports, which are in addition to regular technical reports. Aerojet has a liberal publication policy, and encourages its technical people to write for publication in technical journals which have a wide distribution in the scientific and business communities. In the last five years, a total of approximately 550 articles have been published by Aerojet authors. Technical briefs are published at irregular intervals and are used both within and without the company.

### Sandia Corp.:

The release of information to the public by Sandia Corporation is the responsibility of the Director of Information, 3400, and the Director of Staff Services at Livermore, 8200, or their authorized representatives. While the preparation and release of unclassified information, both technical and nontechnical, is encouraged, it is important that applicable rules and procedures be followed in order that the Corporation may fulfill its obligations to the AEC and maintain as high a standard of quality in released information as in the other products for which it is responsible.

### Westinghouse Electric Corp.:

Westinghouse feels a very strong responsibility to comply fully with our obligations and has a firm policy of supplying this information as quickly and as thoroughly as possible. For this purpose, our Research Laboratories and many other organizations in the Corporation have identified specific personnel to be responsible for identifying and reporting technical achievements obtained from government-sponsored work. These people work in concert with the technical specialists on the contract to provide a thorough review of those items which were derived as a result of our contractual effort.

### North American Aviation, Inc.:

North American recognizes the general benefit to be derived through widespread availability of technical data. Accordingly, we have established specific reporting functions at each of our various corporate diversions whose responsibility it is to identify, document and report new technology as it is generated. These reporting functions have been set up in compliance with the requirements of the standard contractual provisions of the Department of Defense, the National Aeronautics and Space Administration and other Government agencies. We believe that the clauses presently used for this purpose adequately provide for suitable reporting of new technology arising from the performance of Government contracts.

### Ling-Temco-Vought, Inc.:

In addition to disclosing new technology as required by contract, we supplement such disclosures through close working level discussions frequently held between our engineering and program management personnel and government technical personnel.

### The Boeing Co.:

In addition to these contractual obligations we recognize other responsibilities. The program of the Company for its "Independent Research & Development" is submitted annually to the government for technical evaluation. In this program results of past activities, references to technical reports issued (which are available to the government), and identities of principal investigators are given. These serve as an effective means of communication of plans for and results of our non-contracted R. & D. that, together with reports of work under contract, serve to give visibility to the government of the entire R. & D. effort of the Company.

Grumman Aircraft Engineering Corp.:

In addition, we recognize a responsibility to make technical information available to all industry pursuant to the NASA program of technology utilization. For example, a paper entitled "Maximum Utilization of New Manufacturing Engineering Technology" was given by our Mr. E. C. Nezbeda Vice President and Director of Manufacturing before the Society of Automotive Engineers' meeting on October 4, 1966. This paper, a copy of which is enclosed, presented brief summaries of our capabilities in the manufacturing area and invited inquiries should the meeting attendees desire additional information.

Douglas Aircraft Co., Inc.:

We must admit that considerable time and effort of our technical and administrative employees is devoted to fulfilling the technology reporting requirements of Government contracts, particularly those of NASA. Such requirements do tend to detract from the available time of such employees which might otherwise be applied to the prime purpose of the contract. As you know, the scope of NASA's New Technology clause is extremely broad and compliance results in added cost to the Government and the contractor. However, we endeavour to meet all such requirements at the least possible cost to our company and to the Government.

## B. Internal Mechanisms for Technology Transfer, Question 2

Two types of mechanisms exist in addition to the normal communication channels for transferring technology. First, there are permanent mechanisms such as an interdivisional council established by one of the corporations. One of the council's functions is to encourage technology transfer among divisions. Second, there are ad hoc mechanisms in the form of seminars, symposia, and conferences convoked to discuss a significant development or a pressing problem and interdivisional research teams formed to tackle a project that cuts across divisional lines.

Other than these, normal meetings are scheduled which bring together scientists and engineers who have a common interest in some technical field. Information systems have been designed (to a large extent computerized) which can be tapped by researchers when they desire.

It is difficult to tell from the responses how aggressive each corporation's policies are in fostering technology transfer. The answers were not comprehensive enough to make a hard judgment on this. It seems that, except when particular problems come up, the technology is transferred only when the user individual or research team concerned initiates the action. One corporation does pass technical data to its subcontractors and suppliers, the vast majority of which were small businesses.

Overall each corporation was interested in encouraging technology transfer, inhouse. Two respondents could not see the need to go beyond normal communications channels. One corporation, however, tended to discourage or retard the process in a specific circumstance; namely when a division requested research assistance from the central research laboratory, the technology developed was not to be transmitted to other divisions without the sponsor's authority.

EXCERPTS

The Boeing Co.:

In some cases ad hoc technical teams are formed with representatives from several divisions for the purpose of working on technical problems of Company-

wide interest such as atmospheric turbulence, structural fatigue, and noise problems.

### Lockheed Aircraft Corp.:

Several years ago we established a Corporate Research Council under the direction of our Corporate Chief Scientist, Dr. Roy Smelt, and composed of the director of research from each of the divisions. Its task is to review the scope and content of the corporation's research program, not only to assure that the quality of research is high and that interdivisional redundancy is eliminated, but also to encourage transfer of the new technology among the divisions, and to emphasize the exchange of ideas among the researchers themselves.

### North American Aviation, Inc.:

We have found that one of the most effective methods of technology transfer is by way of personal contact and exchange of knowledge. To facilitate such exchange, technical employees are described in a computer data bank on the basis of their particular knowledge and experience, and when a need arises for their expertise, they are quickly identified by a computerized data retrieval system. Besides transferring technology within North American we also pass technical data to subcontractors and suppliers as needed for proper fulfillment of our programs. On some occasions when there was previously no supplier with satisfactory technical capability, our technical aid in establishing such a supplier has been considerable. Much of this infusion has gone to small businesses, which constituted nearly 15,000 out of almost 17,000 North American suppliers in the 1966 fiscal year.

### General Motors Corp.:

As to your second question, General Motors Corporation has a central research laboratory, a central engineering staff, and other operations which are intended to engage in research and development at the over-all Corporate level. The findings of these staffs and activities with respect to the general work performed are made available to the various operating Divisions through reports and technical committees which include representation from the Corporate and Divisional levels. On occasion, these staff operations are requested by a Division to undertake a specific research problem. In such instances their results are not transmitted to other Divisions without authorization from such sponsoring Division.

### Pan American World Airways:

Within our own Company, we utilize normal technical communications channels such as reports, technical library, conferences, group briefings ,written correspondence and direct verbal or telephone communication for transferring technology. This has been adequate in the past and no special mechanisms appear to be required.

### Union Carbide Corp.:

We do not have any special mechanisms (outside of normal technical communications channels) for transferring technology among our various departments, laboratories or locations.

## C. Proprietary and Patent Problems Arising When Reporting New Technology, Question 3

Several corporations evinced a concern that reporting new technology too soon or too extensively would be harmful to the proprietary rights of the corporation. The issue seems to hinge on the division between private or commercial and Government contracted research. One corporation stated that new technology developed within their commercial research and development program should not under any circumstances be reported to the Federal Government. Another corporation found that frequently it was extremely difficult to differentiate between new technology resulting from Government contract and new technology produced using corporate funds. And

still another saw that any expansion of Government reporting requirements would drive a wedge between private and public research and development programs. On the other hand, the synthesis of new technologies into a product ready for production seemed to be the key to one corporation's proprietary interest rather than the bits and pieces of new technology. One respondent felt that the value of reporting was questionable unless the new technology was incorporated into hardware delivered to the Government.

With such a variety of viewpoints it is not possible to draw any final conclusions except that this question has served to expose a private sector concern which justifies further study.

EXCERPTS

General Motors Corp.:

There is, however, a significant difference between such Government contract originated technology and a contractor's proprietary technology. Since proprietary technology is the result of private investment, it is generally recognized as fundamental to our "way-of-life" that the originator possesses property rights in such technology which rights are protectable at law. It is also generally recognized that an important factor in maintaining a healthy and expanding economy is the continuing growth of and investment by private industry in the development of new technology and innovation. It is essential that the contractor's rights in his proprietary technology be maintained inviolate in order to preserve the incentive for such investment. We therefore do not believe that a contractor should be required to report proprietary technology.

Westinghouse Corp.:

From our experience, we have found that it is frequently extremely difficult to determine the specific technical accomplishments that have been actually a direct result of a government contract and those that were produced using our corporate funds. In fact, many government-supported projects are initiated only after the technical feasibility of a new concept has been successfully demonstrated by industry-supported exploratory efforts. The resolution of the proprietary aspects can and has caused considerable debate in the past. In our judgment, assignment of proprietary rights to the industrial contractor can be of significant benefit toward government objectives since the government will have full opportunity to use the development, but the added incentive given to industry in this way can significantly enhance the effectiveness of government expenditures.

Lockheed Aircraft Corp.:

As an additional point, a Government policy which combines requirements for extensive reporting of the technology utilized in contract performance with Government ownership of any inventions relating to the contract work may force companies to insulate their Government-oriented research and development work from that directed toward commercial application. As a result both types of effort would suffer.

The Boeing Co.:

Proprietary ownership considerations, other than patents, usually develop only in connection with work that is directly related to a product line which the developer hopes to offer for sale. The protecting of these proprietary interests has traditionally been the policy of the DOD with the objective of promoting aggressive competition between contractors. It is our belief that the incentive to contractors to produce superior products is enhanced by such a policy. These proprietary considerations relate much more to the synthesis and integration of technologies than to specific items in a specific technical discipline.

Grumman Aircraft Engineering Corp.:

In those instances where the new technology is utilized in the hardware delivered to the Government, the prompt reporting of the new technology transfers that knowledge to the Government earlier than would otherwise occur. However, when the new technology is not utilized in the hardware furnished to the Govern-

ment, it is usually for the reason that it involves that which is either impractical, costly, and/or unsuitable and we therefore question the value to anyone in reporting such new technology. We see no proprietary or patent ownership problems arising from the reporting requirements for the reason that ownership and other rights are spelled out in the New Technology Clause of NASA contracts, the Patent Rights Clause of DOD contracts, as well as the Data clauses contained in those contracts.

Hughes Aircraft Co.:

We recognize a clear obligation to report new technology to the government agency who sponsors the work which gives rise to that new technology, and believe that we discharge this obligation more than fully. We do sometimes encounter difficulty in establishing just which contract supported which invention to our own satisfaction. The problem is not one of accounting, but is rather related to the intrinsic problem of identifying the precise time of an invention vis-a-vis contractual charging and the collateral contributions of various contributors, many of whom may be carrying multiple responsibilities. We sometimes encounter a problem in trying to establish to the satisfaction of our customer whether a concept was conceived and/or reduced to practice prior to initiation of a contract or in connection with the contract. A good deal of our creative work is supported out of company profits and provides the basis upon which major program development contracts are awarded to us. After the fact, it sometimes proves difficult to disentangle the invention and its application. The basic NASA legislation causes us considerable concern in this respect, if it is to be used to claim a company-supported patent on the interpretation that its reduction to actual practice can be made only in space on a NASA program. If this attitude is maintained, it will act as a discouraging factor to many companies who have contributed importantly to space technology out of their own funds. The DOD patent position is different and generally encourages the development and contribution of new concepts by the company. However, this entire question of patents, and the wisdom of government ownership thereof, deserves careful consideration.

### D. Participation in Federal Technology Utilization Programs, Question 4

Almost all of the corporations that responded were participating in the NASA Technology Utilization program both as suppliers and users. While this was the only transfer program cited per se, use of Federal information services such as those provided by DOD and AEC was widespread.

The comments included favorable and unfavorable attitudes. The idea of information flowing to industry from Federal centers was applauded by some because assistance was thereby provided to solve existing problems and to avoid expensive duplicative research and development.

On the other hand, several corporations challenged the Technology Utilization program in theory or in practice. Criticism was expressed that the requirements of the commercial sector were so different from those of the Government sector that transfer would involve considerable additional development effort, therefore usually precluding utilization. From another angle the TU program was considered the right approach with the wrong technology. The extremely high reliability requirements and other esoteric features of NASA-fostered technology would not have great applicability to the cost-conscious commercial sector. While one response indicated nothing new had been received during their participation in the TU program, another saw "spinoff" as a phenomenon that occurred between an industry and the commercial sector directly and not indirectly through or as a result of Government activity.

Three university respondents agreed with the need for diversity in approach. The matching fund requirement for OSTS participation was noted as a weakness in that good ideas for transfer experiments could be sponsored in other programs with full Federal funding.

EXCERPTS

North American Aviation, Inc.:

We believe that these programs are of significant benefit to industry, not only in providing assistance in solving existing problems but also in avoiding what might otherwise be expensive research and development work to obtain information that is already available. However, there are some inherent weaknesses in document oriented information systems such as those just described, the main one being inability to identify and retrieve only that technical information which is applicable to the solution of a specific problem without the necessity of reviewing the vast amount of available data.

Westinghouse Electric Corp.:

Thus far, Westinghouse has used, to a limited extent, some of the technical innovations that have been reported but we have not found many applications for the results of the technology utilization programs. Westinghouse has appreciated the opportunity to review the inputs from the governmental sources but our independent programs in the same areas usually provide preferred solutions for our industrial and commercial use. Economic solutions have not generally been obtained from governmental sources because the space and military technical requirements differ markedly from those imposed on commercial applications. For example, weight and size frequently are not of critical importance in commercial equipment, but cost and certain other requirements are. In our judgment, the technical accomplishments of Government-sponsored development programs have been impressive but these developments cannot be expected to have frequent use in commercial, industrial, and consumer-oriented items.

In reviewing our thoughts on this subject, we feel that perhaps one of the weaknesses in past utilization programs is the great difficulty of effectively demonstrating the usefulness of the technological achievement in a manner that excites interest for industrial and commercial applications. Many of these accomplishments have not been brought to a developmental status which suggests that the technical and economic feasibility are highly probable. Industry must elect to invest large funds to extend the development sufficiently to properly evaluate the usefulness; because this serious void exists, it is our belief that many of the items that have potential value are not picked up and pursued.

Lockheed Aircraft Corp.:

It may be, as suggested in the George Washington University report, that the NASA programs, with their extremely high reliability requirements and their other highly esoteric features, are not the types of programs which could be expected to have the highest level of specific technological developments adaptable to commercial effort. However, the NASA programs may well afford your subcommittee the best "laboratory" for examination of the effect of a highly motivated Government program directed toward technology transfer.

Grumman Aircraft Engineering Corp.:

We receive the NASA Tech Briefs and other publications and material from NASA Headquarters and, of course, as a contractor to NASA contribute to that source of information. Insofar as the significant opportunities and weaknesses of that program are concerned, it has been our experience that much of the material received, and possibly the major portion thereof, has not been new to Grumman. In this connection, however, it must be recognized that Grumman is a large corporation employing many highly qualified and skilled technical personnel and that this experience probably is not shared by the hundreds or thousands of smaller companies receiving this material from NASA.

Douglas Aircraft Co., Inc.:

We are of the opinion that those important items representing spinoffs from Government financed programs would normally be transferred to the civilian

economy by the contractors involved. In other words, contractors developing or discovering an item that may be salable by them or licensable to others for sale would indeed be remiss in their duty to themselves and to their stockholders if they failed to pursue such developments. Well-managed organizations just do not pass up such opportunities. In these instances, it is possible that the transfer of information to the civilian economy, improvement of products, and the associated economic growth of the country would be accomplished by individual contractors at a lower cost than that presently expended by the Government in attempting to promote these items.

## Massachusetts Institute of Technology:

However, technical innovation is only one aspect of the problem, and we also have much to learn about other aspects of technology transfer, including the most effective role of the Federal agencies, the proper degree of centralization of various levels of activity, how to couple the information generated and the specific interests of potential users, developing a better understanding of the innovation process and the factors essential to successful entrepreneurship, understanding the special problems of small business with limited scientific and technical resources, creating the most effective form of referral service or information centers, and learning how to foster receptiveness to innovation in private concerns and overcome attitudinal barriers.

Clearly, the process by which technology can be transferred from its point of origin to utility in another context is extremely complex. Too little is known about the total process. It is for this reason that we feel that the greatest opportunity and strength of the existing Federal programs is their multiplicity and their differences in emphasis and approach.

The Science Information Exchange of the Smithsonian Institution will provide valuable insight into the referral function by which those with similar interests but widely different affiliations and locations can be coupled together. The Commerce Department's Clearinghouse for Federal Scientific and Technical Information will gain useful experience with centralized abstracting, indexing, publishing, bibliographing, literature searching, and document dissemination.

On the other hand, the NASA technology utilization program and the AEC's technology utilization program are providing useful information on a variety of techniques for taking the technology to the user, encouraging its acceptance, and assisting in its development, and these activities are dependent on a complete understanding of the technology originated by each of the agencies.

## University of California:

In regard to the State technical services program we have encountered four major weaknesses First, matching non-Federal funds have been difficult to obtain, and this has limited the number and type of programs that we have been able to start The faculty who are most likely to be able to present new technology of use to industry are the ones most likely to have research contracts which do not require matching funds, and they usually do not have the time to try to obtain matching funds. Second, the Office of State Technical Services (U.S. Department of Commerce) has emphasized that this is to be an action program, and owing to this there have not been sufficient funds for planning purposes. Third, although it would seem that this program was to be a State program, there has been so much direction from the Office of State Technical Services that there is not sufficient opportunity for local initiative. This has resulted in delays and relatively unimaginative programs throughout the country. Fourth, funds are not available for purchases of equipment. This limits libraries in making better use of available documentation, and it limits especially the type of demonstration projects that can be undertaken. If a new method of solid waste disposal, for example, is to be demonstrated, it is not likely that the major components of the facility can be rented.

If these weaknesses can be overcome there are several opportunities that can be exploited. First, libraries could obtain funds to purchase the necessary equipment to use the microfiche copies of reports that are being distributed by Government agencies. It is not economical to use this new technical information format if the equipment necessary to use the format is not available. Second, some faculty members who are now almost entirely research-oriented could be encouraged to spend more effort in making their results available to industry. A major opportunity that the program has already presented has been the development of closer liaison between industry and universities.

University of New Mexico:

As far as the process of technology transfer is concerned, I believe that NASA, in its Regional Dissemination Center program has developed the best existing mechanism for technology transfer, particularly transfer to individual firms. It could well serve as a model for any government-wide system. It combines the two ingredients I feel necessary for a successful transfer process: *first, a central agency* (the NASA Office of Technology Utilization) with the function of collecting, abstracting and computer indexing the technology; *second, local centers* staffed with technical people who are in direct contact with the user and who can convert his problems and needs into efficient retrievals and evaluations of information from the central agency's information bank. Transfer is, in the last analysis, primarily accomplished through people, and these people need to be in personal communication with the user. Also, importantly, the user pays a fee, thus encourging the use of what he receives.

In this respect both the NASA program and the Technical Services Act program have made wise choices in locating the transfer function in universities. There are many reasons why universities provide a proper setting for technology transfer. They are centers of knowledge, and knowledge is the product with which these programs are concerned. They are educational institutions; and, fundamentally, technology transfer is an educational process. They are centers of scientific and engineering excellence and are in the business (at a different level) of creating and disseminating technological information. They are more today than ever before community service oriented, yet serve the community with an objectivity not possible from some private and public organizations.

As for the NASA transfer program itself, it does have one built-in limitation which could be overcome in a government-wide system. Its information base, while encompassing a wide range of technical areas from both governmental (NASA, AEC, DOD, etc.) and other sources, is restricted in its collection to the internal needs of NASA. Therefore it does not include the complete spectrum of technologies either covered by federal research and development or otherwise available to federal agencies. That total coverage and coordination of all federal technological information efforts are desirable is self-evident and should be major objectives of federal policy. There already exists a large number of specialized information centers within the DOD, AEC and other government agencies which offer an excellent base on which to build on overall coordinated federal system.

## E. A Joint Federal and Private Sector Organization, Question 5

A proposed joint Federal and private sector organization was interpreted by most to mean a national data center. The function of dissemination was emphasized in lieu of exploitation. The corporations were interested in strengthening the data centers extant and were leery of establishing an all-embracing system, at least at this time, because of the difficulty of matching services to the widely divergent needs of industry. Again a concern was felt that the data system might encroach on a corporation's proprietary interests because of their overlapping public/private research programs.

Only one respondent saw an entrepreneurial function embodied in the organization. This was met with firm disapproval. The organization would be too far removed from the dynamics of the marketplace. The large-scale failure of the National Research Development Corporation in the United Kingdom was given as an example of a similiar experiment.

One inconsistency cannot be overlooked. In the prior answers it had been pointed out repeatedly that Government-sponsored technology normally requires additional development before it is ready for the commercial sector.

Consequently, it was concluded, the costs involved become a major constraint on the utilization of this technology for other purposes.

Yet, it was not seen to be in the public interest to foster any transfer by, for example, having the joint Government-industry organization underwrite part or all of the additional development costs. The other corporations, by not addressing this point and by not giving the pros and cons of additional steps, did not answer a question they themselves had previously raised.

EXCERPTS

Aerojet General Corp.:

To us, it appears at this time that—

(*a*) Emphasis should be on improving, supporting and using established facilities—Government, as well as university, technical association and other information centers.

(*b*) Improved coding, cross-referencing and access is needed to minimize duplication and facilitate multiple source and machine searching. This may be an appropriate area for Government support and coordination.

Ling-Temco-Vought, Inc.:

This central problem of information transfer is a complex one, and would require a massive data storage and retrieval system designed to accommodate all technical information in the Government's hands. I believe that this is the problem in which the greatest room for improvement exists, and toward which the Government should direct its efforts.

Sandia Corp.:

We do not, however, presently favor the creation of a single national information coordinating center to handle the dissemination of all technology. The creation of such a center would make it necessary to develop procedures applicable to all technology and to all industry. We believe that the problems vary too greatly from one technology to another and from industry to industry for a single unified approach to be practicable. Moreover, we feel that too little is presently known about how technology is transferred to warrant committing our entire resources to a single approach.

Westinghouse Electric Corp.:

As a result, it is improbable that a free exchange of information could be established and sustained. Although this transfer might nominally be restricted to only the results of Federal expenditures, in fact, any meaningful discussions and exchange of information would undoubtedly include additional information derived from non-Government funded programs. It would be extremely difficult for each industrial concern to separate information derived during Government sponsored activity from that derived in industrial programs.

Lockheed Aircraft Corp.:

None of these comments is intended to detract from the desirability of disseminating scientific knowledge resulting from Government-sponsored research. But this should be differentiated from control or direction by a central agency of the commercial utilization of inventions and technology related to Government programs. The latter would be undesirable if for no other reason than that the Government generally is not oriented to planning for and perfecting entry into the marketplace. An example of a large-scale failure in an experiment of this nature was the British National Research Corporation referenced in the House subcommittee's report. The corporation was established by British Parliament in 1949 to exploit commercially federally financed R. & D. It is reported that in the first 10 years of the existence of the corporation, total revenues amounted to slightly more than 1 million pounds, while total expenditures were over 3½ million pounds. The report also referred to a similar effort by the Canadian Government which resulted in only nominal profits during a 12-year history. In a somewhat analogous situation, the U.S. Office of Alien Property is reported to have had little success in exploiting its patents.

## XII. ANALYSIS OF OPINIONS FROM INDEPENDENT NOT-FOR-PROFIT RESEARCH INSTITUTES

The institutes existed as transfer agents for a considerable time before federally controlled technology became a matter of interest. (See p. 79.) To gain the benefit of this experience in the subcommittee study, the following questions were asked of a number of the institutes.

Question 1. To what extent is there a demand and need for new technology on the part of individual firms with which you come in contact?

Question 2. What are the most important technology transfer mechanisms at present (for example, advertising, customer-supplier relationships, consulting engineering, contract research, conventions and trade shows, technical and professional journals, Federal programs, et cetera)?

Question 3. What are the principal strengths and weaknesses of technology transfer programs in the Federal agencies?

Question 4. What is your evaluation of the NASA regional dissemination centers; the State Technical Services Act activities?

Question 5. Can you recommend improvements in any such programs? For example, (*a*) Do you think these programs should be combined and centralized into one Government-wide organization? (*b*) What is your view of a "Comsat"-like approach? (*c*) How do you visualize an organization such as yours fitting into such an approach? (*d*) What changes or innovations in the Federal programs would enable your organization to be of greater assistance?

The replies are analyzed for each question and excerpts of significance are reproduced below.

### A. Demand and Need for New Technology, Question 1

There is evidence that many firms do not interpret their commercial problems in technical terms and therefore do not realize that new technology or R. & D. might be of help. This is particularly so when the business has no technical personnel in management. Even when demand for technology appears, the decision to acquire it involves many nontechnical factors and is a function of personal attitudes and understanding. Much of the work of the institutes is in education which leads to recognition of the need for technology.

Excerpts which illustrate these views follow:

Midwest Research Institute:

> It must be realized however that the decisions to use technology are rarely based on technical considerations alone. Instead, economic, psychological and other behavioral factors are often much more important.
>
> Our general experience and the specific experience with our regional NASA technology utilization program (called ASTRA) shows that there is a large gap between the "demand" for technology and the actual "need".
>
> Most firms we know will concede that new technology can offer better and cheaper ways to do things. But there is not enough incentive on their part to

push for this change. The problem is that not enough is known about the technology diffusion process today to induce more people (potential beneficiaries) to accept new ways of doing things.

### Battelle Memorial Institute:

Because it is the application of technology to solve problems—and not just absorption of technology—that the private firms seek in technology transfer, and because problems of private firms are often quite different from the government problems prompting the origination of the technology, the transfer process often is so complex that the applied technology bears only a general resemblance to that originated under Government funds. In general, the most significant transfer comes from addressing specific commercial problems with Government-sponsored innovation as "part of the kit of tools," rather than clean application of specific bits of Government-sponsored new technology.

### Stanford Research Institute:

The indication is that many firms do not realize the extent to which they need to make use of the "sea" of technology that is being built up around them in order to preserve their future competitive positions. When the realization does strike the technology has often advanced so far that there is no longer time to become familiar with it and apply it to the firm's business. It is therefore our feeling that the need for adapting already existing technology, or in some cases new technology, to the requirements of industry is so much greater than is generally realized.

### IIT Research Institute:

Technically based organizations need new technology to develop new product lines and processes at the most opportune moment and to be aware of technological obsolescence as early as possible to take corrective action.

However, the demand for new technology indicates that some sectors of the economy do not recognize the need for new technology or else lack the resources to effectively take advantage of this demand. Certainly, the larger technically sophisticated industries have a large demand for new technology. In this respect, it appears that new technology begets more new technology. It is the smaller business often unaware of their high need for new technology, that demands it the least. The smaller businesses must become increasingly aware of new technology and should pe aided in determining its significances.

### Southern Research Institute:

It has been our conclusion that successful operation or growth of companies, large or small, seems to depend on entrepreneurship more perhaps than on available new technology. Successful small business is frequently dependent solely on the entrepreneurial ability of one or two individuals. Such enterprises often can gain little from new technology, the use of which frequently calls for further research not available in the company, and new capital investment and risk which the owner is not willing to undertake. It is a fairly general observation that companies having scientific and engineering talent within the organization can use to advantage new developments of R. & D., whereas companies without this ability internally are less likely to benefit from scientific developments.

## B. Transfer Mechanisms, Question 2

The personal contact is noted as the most important transfer mechanism. To the institutes this means contract research or consulting paid for by client firms, plus a limited amount of public service counseling, or participation in Federal or local government aids to business. Within the firm it is necessary to locate a receptive person with some voice in management decisions.

Companies which do not have technical staffs are more likely to depend on customer-supplier relationships directly related to their present business.

Excerpts from the replies are presented below:

Midwest Research Institute:

All of these factors make their own contribution and there is no single "best way" presently, nor do I believe that one "best way" will emerge. In fact, far too much emphasis has been placed on transfer *mechanisms*. Much more emphasis needs now to be placed on the two other elements in the transfer process. The first is the make-up of the *supply* (information to be transferred) in terms of quality, quantity and relevance. Secondly, much more needs to be known about what makes an ultimate *user* first seek and then accept and use technology. We also need to know more about how the supply source works, and how its content can be modified and distilled to make it more meaningful to users.

However, our own experience points over and over again at a mechanism you have not listed. This is the "transfer agent" who is hard to identify and hard to characterize accurately. To put it another way, the more successful transfer programs seem to be characterized by repeated personal contacts between users and suppliers, thus building up a "trusted source" relationship.

Building such relationships is an expensive process requiring careful focus on narrow user audiences, as well as the talents of unusual people to perform the transfer agent role. But since this mechanism appears to work, we should look for ways to build programs around this insight which multiply benefits faster than costs.

Battelle Memorial Institute:

In our view, technology transfer implies the profitable utilization of knowledge. Hence, we would consider that any of the mechanisms listed could be influential in at least initiating the transfer. For ultimate transfer, consulting, engineering, or contract research are representative of the most important mechanisms. They are representative in that they, along with other possibilities not listed, involve the use of individuals in the transfer process. They represent the techno-entrepreneur adaptive to the problem-technology system by virtue of a capability of spanning the new technology and the needs of the industrial sector. Involvement at both ends of the spectrum is probably essential to the successful transfer process.

Mechanisms of technology transfer of lesser importance, but ones that should not be ignored, include technical and professional journals and universities. The greatest contribution of the latter mechanism lies in the diffusion of newly-educated students to the private sector.

Cornell Aeronautical Laboratory:

Although I have few specific comments to offer on the various transfer mechanisms presently employed, it is my observation that one of the most effective has been the independent nonprofit research laboratory. Admittedly, my view may be held parochial or one dimensional, but I question whether the important role such organizations play in technology transfer is sufficiently well understood. Thus, I would point out that CAL's experience over the past 20 years in a wide range of both military and nonmilitary programs substantively illustrates the effectiveness with which such organizations translate technology to diverse applications.

Sometimes specific knowledge and know-how may be transferred directly from the contract researcher to a member of the commercial research community. This does, however, require that direct and often extensive technical communication be established between the groups. CAL, as a recognized authority in the area of hypersonic gas dynamics, was able to transfer to a major chemical concern those aspects of gas dynamics considered pertinent to the improvement of certain chemical processing techniques. A measure of success is evidenced by the fact that today, some years later, this company has a resident staff actively engaged in such research and development.

The Franklin Institute:

The present technology transfer mechanisms, many of which you have cited above, are all characterized by a person-to-person relationship. This characteristic tends to bottleneck the system and there has not yet appeared an effective way of getting around it. While the use of digital computers is making the individual's work more efficient, it is only amplifying the importance of the person in the transfer mechanism. Unless a new and novel approach can be developed,

the only solution to this part of the problem is a reorientation of the training program for engineers and scientists so that personal participation in the transfer mechanism will improve.

## C. Strengths and Weaknesses of Federal Transfer Programs, Question 3

The respondents noted a general lack of knowledge about the transfer process. This makes existing Federal programs take the form of experiments and so they cannot be fairly judged (since even an unsuccessful experimental transfer program may reveal a great deal about the process). Nevertheless, the fact that some effort was taking place was commended by most institutes—reflecting the adage that one must be searching for something in order to find anything.

Weaknesses are obvious at both ends of the process—organizing the information handling system and educating prospective users. The lack of overall policies, internal coordination, and consistent practices was noted by several observers.

Excerpts pertinent to this question follow:

### IIT Research Institute:

Since technology transfer programs by Federal agencies are still in the incipient stages, it is too early to analyze their strengths and weaknesses. However, the major strengths of Federal programs at this time are that the problem has been recognized and that there are active attempts in progress to accomplish technology transfer. Recognizing the fact that there is Federal R. & D. which is useful in the private sector is the first step towards accomplishing technology transfer.

The most significant strides in recent years have been taken by NASA's Technology Utilization Division. TUD places its emphasis on the active transfer of new technology (i.e. the use of an innovation derived from NASA-sponsored research in a nonspace application) rather than a passive transfer consisting solely of disseminating information through publications. This experiment with active transfer has met with some success and some failure, but the significant point is that the experiment is in progress and that NASA is learning to cope with the problem.

There are also some weaknesses in the Federal programs, such as the following:

(*a*) There is a longtime delay from an innovation's inception until industry is informed of its existence.

(*b*) There is difficulty in identifying useful technology and evaluating its potential commercial significance.

(*c*) There is no patent or other type of protection for the organization wishing to use federally sponsored new technology which causes the organization to hesitate before investing funds for adaptive research.

(*d*) Industry does not always recognize that the innovations are seldom directly transferable to commercial use and that additional innovation is required to make such transfers. The NASA film, "NASA Technology Utilization Selected Applications 1965," gives several examples of transfer that simply would not have happened without ingenuity on the part of industry.

(*e*) Industry sometimes views Federal transfer programs with suspicion due to a nonfamiliarity with these programs as well as a feeling that they might not be worthwhile if they promise something for nothing.

### Stanford Research Institute:

Technology developed for the Federal agencies is in general developed for the needs of the Federal agencies. These needs seldom match those of the small business. The quantity and quality of technology developed for application to the needs of Federal agencies is great but the technology can rarely be transferred directly but must be adapted and specially applied to the needs of business by scientists and engineers. Consequently, the Federal programs fall short insofar as they provide business only with existing knowledge but no means is provided to apply the knowledge to the business in question.

## Southwest Research Institute:

Because of our involvement in the Technology Utilization Program, we can comment on question 3 best from this aspect. We serve NASA by having our experienced scientists and engineers review and evaluate for technical merit and possible commercial application, technical innovations developed by NASA in-house and also by its contractors. We find a number of innovations suggested as novel are already in existence in similar form; detailed analyses show some innovations to be not too practical, usually because of lack of certain knowledge on the part of the innovator. However, it should be stressed that development and promotion of such ideas should not be condemned as a shortcoming of the program. Professional people require much encouragement and stimulation to present technical ideas for review. There will always be some "chaff with the wheat," and many good technical innovations are ultimately obtained. NASA makes them available to the scientific and general public as technical briefs or reports. Unfortunately, since only titles of these innovations can be shown on promotional documents announcing their availability, too often specific ideas are not recognized for their potential use. This shortcoming will be overcome by publishing in scientific and technical journals more abstracts of worthwhile innovations.

The principal strength of this program is its basic purpose, making available to the interested public the new technology developed with Federal funds. This material can be very useful. One weakness is that the information does not always reach all potential users.

Another point that might be considered a weakness is the concern of some parties that great commercialization of one certain technological item is necessary to justify the program. Actually, the fact that bits and pieces of this new technology are used broadly in industry should be more than sufficient justification.

## Gulf South Research Institute:

The principal strengths of the transfer programs in the Federal agencies are the extent and depth of information available. The weaknesses are the users' lack of knowledge about the availability of such information and the mechanisms for obtaining such information. Also the users have not developed the habit of going to such sources of information but rather depend on conventional libraries.

## Cornell Aeronautical Laboratories

There are significant advantages when those originally responsible for a technological advance themselves pursue its application toward diverse ends. The motivation to effectively achieve such applications most strongly resides in the inventor himself and his intimate knowledge enables him best to meet the difficult, often subtle, aspects of diverse applications. Independent laboratories, devoted to both Government and industrial research are well suited to this role. I find it doubtful that a centralized organization could effectively duplicate this form of transfer.

With respect particularly to small business, it is my belief that the effective transfer of technology must continue to rely principally upon desire and fiscal ability within the free enterprise system to implement innovations in its own context. There have been many proposals stemming from all levels of research management for congressional action aimed at increasing such motivation by business, large and small to seek new technological ideas. Perhaps principal among these recommendations has been more favorable tax legislation vis-a-vis industrial research. I would only encourage Congress to continue consideration of such proposals.

## Battelle Memorial Institute:

The principal strength in the Federal agencies technology transfer program is that they provide focal points for those with enough entrepreneurial skill. They further serve to emphasize, on a relatively continuing basis, the Government's attempts to transfer public funded knowledge. NASA has accomplished a significant amount in providing improved information to the private sector and other agencies are beginning to follow the approach. Documents such as NASA Sp.-5010 and Sp.-5016 are illustrative of technology available from NASA's Technology Utilization Division. The technology in these documents is presented in a form whereby it can prove useful to problem solution in a defined portion of the private sector.

Although attempts to classify technology so that it is available to the portion of the private sector having the most relevant problems are noteworthy, they nevertheless point out the principal weaknesses of technology transfer programs in the Federal agencies. Dissemination based on solution identification followed by attempts to locate problems tends to inundate a recipient and render him somewhat insensitive. This type of dissemination is the natural result of outgrowth of technology from mission-oriented agencies. The weakness results from failure to recognize that effective transfer can be accomplished only by a reversal of the present process, namely; to seek out problems and then solve them from available technology or match technology to appropriate problems or needs. Present processes ignore the role of the individual that matches technology with need through understanding of both.

Present technology transfer programs also tend to ignore the fact that industry must bear a risk in the technology transfer process and that industry is well equipped to bear this risk, provided that appeal is made to industry through entrepreneurship. It must be recognized that the technology transfer process is expensive and one that the Government is not equipped to handle. It has been stated that: "The cost of making a new technological development commercially successful is often much more than the dollar cost incurred in creating new technology." Steiner, "Improving the Transfer of Government-Sponsored Technology," Business Horizons, volume 9, No. 3, fall, 1966, page 55.

### Midwest Research Institute:

The strengths of the Federal programs are (*a*) the fact that such activity is underway, and (*b*) that each of the agencies is experimenting and learning a considerable amount as each month passes.

The weaknesses are (*a*) most efforts are limited to operational programs by law (i.e., to get "results"). There is no mandate or legislative authority to do the necessary underlying research (which may be largely psychological of sociological in nature), to overcome our inadequate basic understanding of the technical diffusion process.

(*b*) Insufficient effort has been devoted to identifying good prospects (users) for transfer. The success of biomedical applications team program that we are conducting for NASA illustrates the value of identifying users (in this case, M.D.'s in clinical and research activities) having common needs (e.g., instrumentation and bioengineering devices) and then designing a program to serve and reorganize the information supply (NASA pool of technology) to meet these needs.

(*c*) There needs to be much more effort addressed to translating and researching the information supply into more usable "civilian" terms.

(*d*) Too much attention is addressed to different forms of "transfer mechanisms."

(*e*) Finally, there are no overall national policies or stated goals to coordinate the several efforts and to provide overall focus.

## D. Evaluation of NASA Regional Dissemination Centers and the Office of State Technical Services, Question 4

Somewhat surprisingly, about half the institutes have not been directly involved with the NASA centers for technology transfer. The centers are, in a sense, competitors of the institutes and only one is located at an institute (Midwest Research Institute). The fact that the centers were beginning to become self-supporting through user fees was taken as an indicator that they were doing a satisfactory job.

The State Technical Services activities were appraised as doubtful to excellent with the comment that the requirement of a program for each State meant spreading the available funds so thin that results would be slow in appearing.

Excerpts from the respondents follow.

Southwest Research Institute:

The NASA regional dissemination centers are accomplishing their very difficult work. They are individually growing in size, and their number is expanding. The companies they serve, for a fee, are benefitting from NASA technical information after it has been screened to provide individual companies with only relevant data. Unfortunately, even though fees are very nominal, the centers are reaching only a few—and mostly major—companies who understand research and its resulting benefits. These companies expect primarily to obtain generally useful, new technical knowledge and only on occasion, some great gem of information. It would seem that the smaller companies with more to gain from an influx of new technology do not understand the philosophy of research and development.

The State technical services program is newer and appears to be moving more slowly. Perhaps there has been a need for State and Federal administrators to coordinate their activities. We understand that the NASA Office of Technology Utilization is now making NASA information available through the State programs. Our limited knowledge of their specific activities will not allow us to comment fairly about them. Like NASA, they probably have not reached the potential users of their services. Possibly more local newspaper publicity and contact with local associations of manufacturers to describe the program are in order.

Battelle Memorial Institute:

The dissemination centers have value in that they serve a relatively small audience, and keep the idea of the potential of technology transfer constantly before numerous industrial firms which otherwise would be unaware of potential opportunities. They suffer from the previously discussed disadvantages of technology transfer by dissemination alone. There is an element of "Here is the answer; what is the question?"

The activities of the Office of State Technical Services have not been underway for a long enough period of time to evaluate. Certainly, if they turn out as well as has the Department of Agriculture's extension services program in focusing on addressing problems using technology rather than just "scattering technology," they will be most effective. The possibility that State technical service programs may duplicate some presently existing programs could cause industry to become confused as to whom they should approach.

IIT Research Institute:

Again, an evaluation of the NASA regional dissemination centers and the State Technical Services Act is difficult because these developments are so recent. The NASA RDC's appear to be effective transfer organizations, if only because they are signing fee-paying member companies into the program at a rapid rate with a low percentage of organizations failing to renew their memberships. Their computerized methods of storing and retrieving documents, while suffering from the lack of a "perfect" indexing system, seem well suited as a major tool for achieving technology transfer and reducing the duplication of R. & D. efforts.

The State Technical Services Act introduces the concept of the States playing a major role in tailoring specific programs to meet their singular requirements. Only time will reveal the effectiveness of this concept; however, we doubt that this program can be as successful as the NASA program.

## E. Recommended Improvements and the Role of the Institutes, Question 5

The research institutes were almost equally divided on the question of centralization of Federal efforts. Opponents were fearful that a single "best" approach would be chosen at too early a time. Diversity of approach has its usual appeal. Endorsement of centralization was on the basis of achieving common methods for information handling and a single contact point for users. Many respondents commented that even without centralization, there should be much more coordination among transfer programs. Some sort of "capping agency" is

needed to evaluate efforts and select the most promising experiments for the limited funds during the period of research on the transfer process. Ultimately, technology transfer may be coordinated and centralized as will scientific information.

The Comsat concept was not viewed with favor, principally because it is difficult to visualize proprietary protection which would insure that the transfer agency received a share of the benefits. The research institutes felt strongly (with an admission of self-service) that they were a proper bridging device. Federally controlled technology can be coupled to business problems through the trusted source of a regional research institute. The replies indicated that each institute foresaw immediate local opportunities which were not being met because of a lack of money and manpower.

Excerpts on this question follow:

Battelle Memorial Institute:

Battelle is aware of the several studies performed by Systems Development Corp. for the Committee on Scientific and Technical Information (COSATI) of the Federal Council for Science and Technology (FCST). The implications of the nature of the "charters" of NASA, AEC, and DOD, particularly as the charters relate to an obligation to insure technology transfer to the private sector are recognized. Further, we are aware of the importance of actions of the U.S. Congress with respect to this problem as well as to economic considerations. Based on these as well as other considerations, the viewpoint that the technology transfer functions of NASA, AEC, OSTS, DOD, and so forth, should be combined under the Department of Commerce, operated by the Intitute of Applied Technology with the Clearinghouse for Federal Scientific and Technical Information (CFSTI) serving as the central processing and storage unit is of some merit. This approach could be enhanced by the presence in each State of a technology transfer office. Each State technology transfer office should be in direct and continuous communication with the Federal-level technology transfer office in the Institute for Applied Technology, and also in direct contact with the CFSTI, wherein the central information store of public funded unclassified, unlimited information would be available for retrieval and transmittal to the claimants of the State technology transfer offices.

On the other hand, the inefficiency of occasional duplication that would be eliminated by the above approach might be outweighed by the advantages of interagency competition to excel in technology transfer.

Other improvements in programs should center around the suggestions made in connection with the discussion of technology transfer mechanisms of question 2 and weaknesses of programs in question 3. This would involve greater recognition of entrepreneurship as a means of accomplishing the healthy transfusion of technology into the private sector and the ability of industry to be vitalized by such an approach. *The role of the individual in the problem-technology matching relationship and the unique role that industry can play in the adaptation process must not be overlooked.*

(*b*) What is your view of a Comsat-like approach?

We assume the Comsat-like approach refers to the several conclusions of SDC's national document handling system report, and to COSATI's recommendations to the FCST. If this is true, we do not favor the Comsat approach, on the grounds that we recognize two separate "information" areas, (1) that of information developed by public funded information, and (2) that otherwise developed. We do not believe that these can be handled under one structure—even if implemented in the private sector. Rather, we hold the view that the Federal Government should exercise the leadership and management skill necessary to effectively exploit that information developed using public funds, and to recognize that the private sector (including professional societies) be free to exploit not only public funded but also privately funded scientific and technical information.

(c) How do you visualize an organization such as yours fitting into such an approach?

In the event that a Comsat-type corporation were founded, it is expected that organizations such as Battelle would participate mostly through supplying some of the staff who would be involved in the operation of the Technology Transfer Comsat. Also, and provided several of our Government sponsors were to approve, it is likely that some of the unclassified unlimited products of Battelle-operated information analysis centers would be further disseminated by Comsat. Conceivably the Comsat would serve to refer numerous inquiries to Battelle for preparation of technical responses.

It is not likely that Battelle's information analysis centers would depend on the Comsat procedures since much of the information utilized by our information analysis centers is too new to have been acquired, indexed, announced, and accessioned by a central depot. Indeed, if Battelle were to depend only on the published literature, then at best it would be 12 months to 2 years behind the times.

(d) What changes or innovations in the Federal programs would enable your organization to be of greater assistance?

As an independent, endowed, not-for-profit research institute devoted to science and research, Battelle can provide assistance that would touch virtually all facets of the technology transfer process. This would include expansion of its present role as well as the ability to offer even greater assistance in connection with the changed programs suggested herein. At the present time, Battelle offers considerable assistance to the major ongoing Federal technology transfer programs by operation of several important information analysis centers for the Department of Defense, NASA, AEC, and Arms Control and Disarmament Agency (e.g., Defense Metals Information Center, Battelle-Defender Information Analysis Center, Remote Area Conflict Information Center, Radiation Effects Information Center, and Arms Control Technical Information and Analysis Center). Also, Battelle maintains an aggressive information acquisition program to insure that its information holdings are as current and as valid as possible. In this role, Battelle makes a contribution to an important aspect of technology transfer, namely; insuring the availability of usable information. Representative of suggestions made in connection with these programs are such words as security classification and control, contract requirements for reports, access procedures for using DDC held information for an AEC project, or vice versa, and standardized Government-wide thesauri, indexes, abstracts, and announcement media.

Recognizing that a key to the technology transfer process lies with the individual, Battelle has available the services of numerous individuals aware of the needs and problems of the private sector and at the same time skilled in the adaptation of technology.

Battelle's contract research is sponsored both by Government and industry; all of the departments and most of the individual researchers at Battelle have worked on programs for both groups. Thus Battelle researchers often approach commercial problems with a "kit of research tools" developed in good part through Government-sponsored technology, and are able to apply the latter to the former in the problem-focused manner that helps the commercial firm.

Battelle specialists that perform research on economic, marketing, and other business considerations in the use of new technology in commercial industry, are particularly well situated to aid in planning and achieving effective (from the business viewpoint) industrial use of Government-sponsored new technology.

In addition, Battelle itself participates in the technoentrepreneurial process through the operation of a not-for-profit subsidiary—The Battelle Development Corp. The stated purpose of this subsidiary is to support scientific research and to make the results available to industry for the benefit of the public. During its 31-year history, The Battelle Development Corp. has gained a wealth of experience in bridging the gap between the inventor's scientific concept and utilization in industry. It is envisioned that organizations such as The Battelle Development Corp. having existing technology transfer capability could play a most important and effective role in future Federal programs at a minimum cost to the Government.

Recognizing even further that the practical utilization of the results of creative research in a free society depends on the element of technical risk as well as technoentrepreneurship, Battelle in 1963 established a profitmaking subsidiary,

Scientific Advances, Inc. In its operation, Scientific Advances assumes the technical risk in the form of demonstration of the commercial feasibility of various "discoveries and inventions." By establishing Scientific Advances, Inc., to play a role in the technology transfer process, Battelle has learned that which is now being recognized in connection with the transfer of defense-space technology, namely: "Industry must play the central role in transfer; the job is one of matching new technologies to diverse needs throughout the economy, and industry is clearly best equipped to perform this work." "Commercial Profits from Defense-Space Technology", Purcell, ed., The Schur Co., Boston, 1965. One of the first products manufactured by Scientific Advances, Inc., was a subminiature absolute-pressure transducer developed at Battelle under Government contract whereby Battelle was entitled to retain title to the invention with royalty-free license provisions to the Government. Organizations such as Scientific Advances that are skilled in assuming technical risk and have an available technoentrepreneurial talent could also play an important role in future Federal programs.

## Midwest Research Institute:

I would advise strongly against centralizing all Federal transfer programs in the near future because the state of the art does not yet permit the selection of the "best approach". We need more experimentation to determine this.

There might well be some real benefits in congressional recognition and encouragement of further cooperative efforts and experiment among the several existing agency programs. "Technology transfer" is needed here, too. Furthermore, added effort to centralize and expand the supply of information for dissemination should make all the programs more effective. Currently, each agency tends to focus first on the information pool it generates. But I suggest that keeping some competition alive among the programs during this learning stage is highly constructive.

With respect to a "Comsat-type approach," it is hard to comment without knowing more of what is contemplated. A literal adaptation of Comsat to exploitation of Government-developed technology doesn't seem to fit. Comsat was created to focus resources on a closely defined technical systems development problem. On the other hand, the real problems in technology transfer are not technical in nature and the payoffs are external to the generating agency—not directly controllable.

But if you are speaking more generally of linking private and public enterprise, then I would strongly favor exploration of alternative modes and routes. There may well be ways to incorporate the transfer agency concept to make better use of our national technology resource. We must be careful, however, that new approaches do not further isolate and discourage participation by smaller or less energized companies.

MRI and other regionally based institutes can and should play a major role in new private-public approaches. For one reason, as I've mentioned above, an inherent part of our business is technology transfer. For another, it is important to recognize the major differences among regions in the United States, i.e., business acceptance of technology differs widely among regions as well as among industries. Experience has taught MRI a great deal about the sociology of Midwest business, for example, so we could make a unique contribution here as could other similar institutions in their own regions.

Finally, MRI and its counterpart institutes are "future oriented" and recognize that the value of new technology is not intrinsic—it lies in the timeliness of application and development. I therefore suggest that you look at these institutes as they are—an existing, trained, and experienced interface between industry and the Nation's pool of technological resources. It may well prove that we have already the form of corporate transfer agent which you are seeking.

## Franklin Institute:

I believe the total problem of technology transfer is so complex that a solution should not be built around one Government-wide organization. The centralization should take the form of encouraging the development of transfer mechanisms in all appropriate departments of the Government, and should play the role of providing liaison among them.

## Gulf South Research Institute:

I would like to recommend that all of the Government information programs be centralized under one Government-wide organization, but that the Government

include some mechanism for evaluating and selecting significant new information and getting it delivered to the obvious appreciative users.

I am not enthusiastic about something as innovative as the "Comsat" approach until we have learned to make better use of our conventional systems.

Our organization could be very effective in evaluating, selecting and delivering significant new information to the appropriate users.

Adequate funding to carry out the task described under (c).

## IIT Research Institute:

There are some improvements which we can visualize at this time. The acquisition, evaluation, storage, and retrieval of knowledge will be an important element of the economy in the next 30 years. To meet future requirements, a centralization of information would seem worthwhile at the present time. Perhaps NASA, AEC, DOD, Department of Commerce, etc., should begin to use common methods for identifying, evaluating, and disseminating new technology as well as for the classification, storage, and retrieval of this technology. Some initial success in this direction was shown by the recent joining of NASA and AEC into a joint technology brief program.

We do not feel a "Comsat-like" approach would effectively handle this program. Perhaps it could work as the centralized storehouse but we feel the dissemination can best be handled by many groups scattered about the country more in tune with the needs of their regions. Universities and research institutes could probably play a major role in this respect. Particularly the research institutes who are in the business of "bridging the gap" between basic research and industry's needs, and should be of considerable assistance, both from a technology and geographic point of view.

We at IIT Research Institute have been working for NASA for several years on screening of innovations presented by NASA laboratories and contractors. We have come to recognize that many of the suggestions are not transferable at this time but we do see enough good to feel the program as operated today is worthwhile. No doubt, additional experience will improve the transfer but we are inclined to feel it will never reach the magnitude that many, particularly the proponents of the State Technical Services Act hope for. Technology does not transfer from one user to another or from one discipline to another that easily.

## Stanford Research Institute:

We do not believe it is in the country's best interest to attempt to centralize transfer programs or mechanisms into a single Government organization. New technology and accompanying innovations arise from the special needs and stimulation of various Federal agencies. This takes place in agency laboratories, industrial, not-for-profit and university laboratories. This variety of sources is a national strength in itself.

The transfer mechanism is best accomplished by industrial and not-for-profit institutions who perform industrial and Government research and development. They are acquainted with the work going on in many Federal agencies and at the same time have working relations with industry and business. A not-for-profit institute such as the Stanford Research Institute would be especially useful in translating Government supported technology into the civilian economy because it works for a large segment of business and is by its nature objective.

The translation does not take place well now and the presence of a central government agency would, in our opinion, only add another "slowing down" link in the chain. We think as you do that it is important to enhance the process. An attractive and effective method to accomplish the transfer would be to create funds within the Federal technology generating and supporting agencies to fund proposals aimed only for the application of the technology they generate to the improvement and development of industrial and business products, processes and services. One of the basic problems is the funding necessary to make the transfer by scientists and engineers. The application of modern technology to industry is expensive, and businesses are often reluctant to take the financial risk. Many small businesses and some larger firms do not process the applied scientists necessary to effect the transfer of technology.

For example, SRI, the not-for-profit institute which I represent, could be very effective in carrying out the technology transfer on an objective basis, if transfer funds could be applied for, since it is well acquainted with the technology generated by Federal agencies, is very familiar with the economics of various industries, and

understands at the same time the technological requirements of industry in order that they maintain their competitive position.

In addition, the institute staff of about 3,000 people cover all the essential scientific and technical disciplines and skills that would be required to make the transfer in an optimum fashion.

## Southwest Research Institute:

(*a*) Centralization of such services has merit because effort can be multiplied but if the State program is diminished, the possibility of greater local, small company penetration with the new technology information is lost. All programs deserve an incubation period before being required to conclusively prove that they are producing worthwhile results.

(*b*) The Comsat approach is interesting, but the technology and interests of the companies involved in the use of new technology are so broad and varied that proper organization of a group to direct the work might be difficult.

(*c*) Southwest is already a participant in the NASA technology utilization program, as noted, and is constantly trying to bring new technology to the attention of its clients. We have offered our services and assistance in the State technical services program on both a local and regional basis. Southwest could serve any organization both in gathering and classifying new technology information and in disseminating it for use by interested parties.

(*d*) An organization can always be of greater assistance if more manpower is applied. Specifically, we could undertake the task of educating the smaller industrialist to use profitably the new technology being made available to him. This is not a problem of present organization of the Federal programs. Possibly all we need to do is suggest our willingness to do such work to one or both of the present technology transfer organizations.

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