Patent Problems 177 & 190

TECHNOLOGY TRANSFER

HEARINGS

BEFORE THE

SUBCOMMITTEE ON SCIENCE AND TECHNOLOGY

OF THE

SELECT COMMITTEE ON SMALL BUSINESS

UNITED STATES SENATE

NINETIETH CONGRESS

FIRST SESSION

ON

POLICY PLANNING FOR TECHNOLOGY TRANSFER

SEPTEMBER 20, 26, 27, 28, AND OCTOBER 12, 1967

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HEARING DATES

TECHNOLOGY TRANSFER

WEDNESDAY, SEPTEMBER 20, 1967

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE AND TECHNOLOGY
OF THE SELECT COMMITTEE ON SMALL BUSINESS,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10:10 a.m., in room 1202, New Senate Office Building, Senator Jennings Randolph (chairman) presiding.

Present: Senators Randolph, Javits, and Baker.

Also present: Blake O'Connor, professional staff member; Daniel T. Coughlin, minority counsel; Richard A. Carpenter, Legislative Reference Service, Library of Congress, and Shirley Bartlett, committee staff.

Senator RANDOLPH. Good morning, ladies and gentlemen. The Subcommittee on Science and Technology of the Senate Select Committee on Small Business is interested in policy planning for technology transfer. That is a rather difficult subject, but we will get into exactly what we mean as the hearings progress.

For the record, I would like to refer to the report of our subcommittee on "Policy Planning for Technology Transfer" which was prepared by the Science Policy Research Division of the Legislative Reference Service of the Library of Congress. This material, we feel, is very important to have in mind as we open this hearing today. There were certain conclusions which were set forth. Without objection, those conclusions which are on page 4 of the report will be included at this point in the record.

(The document referred to follows:)

CONCLUSIONS

The analysis of information in this report shows the following relationships in technology transfer:

1. Public funds generate about two-thirds of the available technology and the Government has a responsibility to get full benefits from this knowledge.

2. Federally derived technology has appreciable utility to industry and to other public programs at all levels of government. Well documented "second applications" are appearing with increasing frequency.

3. Therefore, Federal Government efforts are warranted in devising and operating programs to make this technology readily available to all users (see p. 58).

4. The private sector innovation rate is affected by a "climate" of which the availability of technology is an important part. Traditional sources of technology need to be expanded beyond the permanent staff capabilities of many firms.

5. Reeducation and counseling as to the technological needs of industry are necessary before strong demands for new information will arise. The Federal Government can logically participate in technical services but local and individ-

ual initiative will be most important in recognizing the potential for technology transfer.

6. At the present time, there is no uniform policy or practice among Federal agencies as to technology transfer. The NASA and AEC pursue a central-agency concept of collecting and disseminating technology. The DOD makes no special effort for the transfer of its majority share of Government-sponsored technology. The Office of State Technical Services concentrates on identifying user needs. The clarification of Government responsibilities, including patent policy for R. & D. contracts, is essential to any expanded transfer programs (see pp. 121 and 138).

7. Additional public discussion and formulation of opinion from both private and public sectors is necessary before detailed policy planning can proceed. The lack of "feed back" response from users of new technology makes difficult the evaluation of any particular transfer method. Ongoing Federal programs should be examined more intensely for evidence of acceptance and efficiency.

Senator RANDOLPH. Technology transfer has as its purpose, I think we are rather generally agreed, the application of existing science and engineering knowledge to solve diverse problems in commerce and public programs. It seems to the chairman that we could give it an application by referring to an example that would quite clearly indicate that technology originally developed in military and space projects can be utilized in new approaches to crime prevention—I mention this fact of crime prevention at the outset because we have just been informed by the Federal Bureau of Investigation that in the first 6 months of 1967, crime has increased by 18 percent over the like period of the first 6 months of 1966. The designation of serious crimes has had an increase in this period over the prior period of 17 percent. I may place in the record the increases which are shocking in armed robberies and other categories, but I will not use the time except to indicate that whatever we can do in applying science and technology to the prevention of crime in the United States is certainly a most important factor as we move forward with these hearings.

How shall we apply the technology and planning to pollution abatement? In this area, our subcommittee of the Senate Public Works Committee, the group headed by the distinguished and knowledgeable Senator, Mr. Muskie of Maine, has been going into these problems of air and water pollution in depth, and we have passed certain beginning legislation in the Congress of the United States. So what we are talking about has a very definite impact on pollution problems.

Then there is another factor which concerns itself with urban transportation, and this, of course, is of importance. I am just remembering today, to use another specific, that approximately 70 percent of our population in this country is living on 1 percent of the land, and 80 percent of our industry is centered on 1 percent of the land. And I have begun to think more recently that the highways that we have been constructing, are not only the roads which bring those persons into the metropolitan areas to work, who live in suburbs or even extended areas that might be called rural in nature, but the highways, I think, are going to be used by people who are going to be working in plants in the rural areas of the United States. This is my own thinking. It is not backed up by any program that we have. But I think there is an answer, at least in part, for a more intelligent use of the countryside as contrasted with the congested urban areas.

Here we talk of urban transportation. In West Virginia now, we have three nationally known companies which are in the process of

constructing and operating plants, not in Charleston, W. Va., with 100,000 population, and some of the other cities, although we have no large cities in our State, but these companies bring new plants into being in rural areas. I think of one county where the county seat—Franklin, W. Va.—has perhaps 1,200 persons. This is where the plants will be located, in a rural county. The reasons are many, of course—including a steady labor supply. I will not go into that further except to say that urban transportation is not just alone, in my concept, to bring workers into the metropolitan and congested areas, but these roads may also carry people out in increasing numbers to develop the countryside.

Now, American business will find profitable processing, manufacturing, and service opportunities in the vast reservoir of technology from federally funded research and development programs. The critical factors in technology transfer are processing the useful information and interpreting the problems to be solved in terms of the needed technology which seems to be applicable. $100 billion of public funds have been invested in research and development within the last decade. This represents, I am told, two-thirds of all the technology available in the United States. There is great potential for technology transfer—we call it secondary utilization—additional application beyond the purpose for which the technology was originally created.

Our subcommittee, and I think the members of the subcommittee even though they are not here this morning, have been diligently at work—as individual members of the subcommittee—on these problems. It is hoped that we can be productive in our hearings to stimulate further public discussion in this area. We are going to solicit testimony from industry which performs under research and development. We are going to hear from trade associations and from business groups and the potential users, of course, of Government-controlled information. Organizations which have long worked in the transfer process itself, I think, should have some practical experiences to report during our hearings.

And then lastly, the Federal agencies themselves. These agencies which dominate, and I use that word advisedly, the research and development picture, will present the information about the present and the future programs.

I think it should be a matter of record that the subcommittee—at least I, as chairman of the subcommittee, would say—have seen little evidence of interest in the Federal transfer programs from large technically oriented manufacturers. This reaction from the larger organizations concerns me. I will have, I hope, helpful comment and discussion on this point as the hearings progress. Such companies may be self-sufficient in technology. But this reminds us that small businesses might have special need for the results of Government research and development programs. Therefore, we are pleased to hear today from witnesses who will discuss technology transfer to small or nontechnical industries.

The goal of our study is to assure the maximum utilization of technology from federally sponsored research and development programs. I believe our hearings will provide a basis for policy deter-

mination by the Congress. The information we develop should be of interest to those committees which have responsibility for the $100 billion in Government funds which have been expended in the last 10 years for science and engineering. We believe that technology transfer, if properly conducted, can multiply the return on this investment many times.

We welcome our witnesses today.

(The prepared statement of Senator Randolph follows:)

OPENING STATEMENT BY SENATOR JENNINGS RANDOLPH

It is a privilege to open the Technology Transfer hearings of the Subcommittee on Science and Technology. As you know, these hearings will be a continuation and expansion of our earlier report, Policy Planning for Technology Transfer.

Technology Transfer has as its purpose the application of existing science and engineering knowledge to solve diverse problems in commerce and public programs. For example, it seems quite likely that technology originally developed in military and space projects can be utilized in new approaches to crime prevention, air and water pollution abatement, and urban transportation. American business will find profitable processing, manufacturing, and service opportunities in the vast reservoir of technology from Federally funded R & D programs. The critical factors in technology transfer are processing the useful information and interpreting the problems to be solved in terms of the needed technology. 100 billion dollars of public funds have been invested in R & D within the last decade. This represents ⅔ of all the technology available in the United States. There is great potential for technology transfer—secondary utilization—additional application beyond the purpose for which it was originally created.

These conclusions are drawn from Senate Document 15, "Policy Planning for Technology Transfer," prepared for the Subcommittee by Richard A. Carpenter, Senior Specialist in the Legislative Reference Service. The report states that Federal agencies differ greatly in their efforts to assure the fullest beneficial use of research and development results generated at their direction. Furthermore, the lack of "feed back" commentary from recipients of transferred technology makes the evaluation and comparison of different approaches difficult. Our Subcommittee believes that it will be productive to stimulate this additional public discussion of this concept. Testimony is being solicited from highly technical industries which perform a large part of the R & D in the United States. We are interested in their evaluation of Federal transfer efforts and the problem of identifying and reporting useful new technology.

We will hear from trade associations and business groups which are potential users of government controlled information. They may contribute suggestions as to the necessary conditions for receptivity and development of facts and knowledge originated elsewhere. Those businesses which do not contain technical resources of their own may nevertheless make significant use of transferred technology. The transfer task will be most difficult with these firms but the potential for economic growth is also the greatest.

Organizations which have long worked in the transfer process itself should have practical experiences to report. Officials of the independent research institutes, universities, trade journals, and state technical service agencies will testify.

Finally, the Federal agencies which dominate the R & D picture, and therefore control the new technology, will bring the Subcommittee information on their present programs and suggestions for the future.

It should be noted that the Subcommittee has seen little evidence of interest in the Federal Transfer Programs from large technically oriented manufacturers. This reaction from the larger organizations concerns me. I will have more comment and discussion on this point as the hearings progress. Such companies may be self-sufficient in technology. But this reminds us that small businesses might have special need for the results of government R & D. Therefore, we are pleased to hear today from witnesses who will discuss technology transfer to small or nontechnical industries.

The goal of our study is to assure the maximum utilization of technology from Federally sponsored R & D programs. I believe our hearings will provide a basis for policy determination by the Congress. The information we develop should be of interest to those Committees which have responsibility for the 100 billion dollars in government funds which have been expended in the last 10 years for science and engineering. We believe that technology transfer, if properly conducted, can multiply the return on this investment many times.

We welcome our witnesses today.

Senator RANDOLPH. Is there any comment from my colleagues before we hear our first witness?

(There was no response.)

Senator RANDOLPH. Robert H. Gifford, would you identify yourself please, and make such comment as you feel will be helpful?

STATEMENT OF ROBERT H. GIFFORD, EXECUTIVE DIRECTOR, SOUTHERN INTERSTATE NUCLEAR BOARD, ATLANTA, GA.; ACCOMPANIED BY WYATT M. ROGERS, JR., DEPUTY DIRECTOR FOR OPERATIONS

Mr. GIFFORD. Thank you very much, Mr. Chairman. I would like to ask for a moment to introduce my associate, Mr. Wyatt Rogers, who is the deputy director for operations of the Southern Interstate Nuclear Board.

I make specific reference, Mr. Chairman, to the fact that he joined our organization from West Virginia, having lived there before his association with the SINB. He was director of the science and technology unit of the department of commerce of your State, and we feel he is making an excellent contribution to our program as well.

Senator RANDOLPH. Mr. Gifford, I think that I really mentioned West Virginia partially as an example here because of Mr. Rogers' cooperation with you today. He even smiled a little. I was provencial in this end.

Mr. GIFFORD. Thank you, Mr. Chairman, for that comment.

My name is Robert H. Gifford. I am appearing here as representative of the Southern Interstate Nuclear Board in my functional capacity as executive director.

The SINB, with headquarters in Atlanta, Ga., is the administrative body of the Southern Interstate Nuclear Compact. SINB is the Nation's first non-Federal, public supported, interstate advisory and developmental agency in the nuclear and space fields. As the official agency of the Southern Governors' Conference, the SINB serves 17 States from Florida to Delaware, west to Missouri, south to Oklahoma and Texas, and back east, comprising approximately one-third of the Nation.

Formally established in 1961, the interstate agreement has been ratified by the legislatures of each of the member States and approved by the U.S. Congress under Public Law 87–563. The Federal act was signed into law by the late President John F. Kennedy on July 31, 1962.

The effectiveness of the Southern Interstate Nuclear Board is attributable, in large part, to its unique makeup as a statutory agency in and among the 17 jurisdictions. This makes SINB an extension of

government in each of the States as though its headquarters were physically located within the State. SINB can call on individuals and services of State agencies and institutions without the necessity for additional authority or individual contractual arrangements. As a statutory instrumentality of the State, SINB is privy to the same intrastate relationships as the industrial development commission, department of public health, or other official bodies. This circumstance also enables the board to draw selectively on the multiple talents and resources of the community of States. The approach produces a reservoir of talent and a level of expertise beyond that possessed by any one State or institution. Under this coordinated approach, it is possible to execute a broad spectrum of programs which one State acting independently perhaps could not carry out because of cost or technical demands.

SINB also has the capacity to shift attention expertly from one field of activity to another by drawing into the program on a consultant basis, experts with demonstrated knowledge and capabilities in the instant field of investigation or service. Under the direction of a small staff, which functions primarily as a directional and catalytic group, the Southern Interstate Nuclear Board within the last 3 years has made use of—in varying degrees—more than 200 professional consultants, including eight medical doctors from seven States, 13 attorneys from eight States, seven professional engineers from five States, eight economists from six States, and 27 Ph. D.'s in fields such as public health, radiation technology, reactor development, agriculture, and others. Other professionals were involved representing such areas as transportation, insurance, wood uses, management planning, and food technology.

Included in this overall representation were program participants from 17 universities in 13 States and industrial and professional people from such diverse points as Florida, New York, Illinois, Texas, Utah, California, and New Mexico. Participants and advisers on SINB projects included representatives from 44 industrial firms in 20 States, as well as 17 associations, institutions or nonprofit organizations in 11 States.

Time will not permit my covering the six major projects which the SINB has carried out in this period in addition to its other programmatic activities, but I would like to make specific reference to two projects which, I believe, will illustrate our agency's direct involvement in technology utilization.

The Southern Interstate Nuclear Board, in cooperation with the Atomic Energy Commission, conducted the Nation's first formal program on the commercialization of irradiated wood-plastic combinations. WPC results from a process where woods are impregnated with a liquid monomer, such as methyl methacrylate, then exposed to ionizing radiation to induce polymerization of the wood and plastic. The end product has many improved characteristics. Among these are hardness, increased dimensional stability and resistance to warping and scratching. It is possible also to introduce pigment, fire resistance materials, and other desirable additives. At the time of the SINB project, wood-plastic combinations had received no significant recognition by the wood products industry and was still in the laboratory stage of development.

SINB brought into its consultant team representatives from the most knowledgeable industrial research and university programs engaged in the development experiments with this product. This team was used in the conduct of a series of 12 major information-demonstration programs carried out in an equal number of Southern States. By making use of the office of the Governor in each of these States, invitations were extended to a carefully selected group of key wood products officials. These individuals were identified through State industrial sources and through such associations as Southern Pine, Hardwood Dimension Manufacturers, Hardwood Plywood Manufacturers, Southern Furniture Manufacturers, and others.

Senator RANDOLPH. Mr. Gifford, at this point, I want to go back to page 3. You say there:

> At the time of the SINB project, wood-plastic combinations had received no significant recognition by the wood products industry and was still in the laboratory stage of development.

As you read it, I did not quite feel the impact, but as you went forward, I would like you to tell me why.

Mr. GIFFORD. I think it was just the chronology of development. It happens that the process was developed by Dr. James Kent at the University of West Virginia in Morgantown. Up to that point, the work had been conducted on a laboratory scale and had not been offered for experimentation or consideration to any measurable degree by private industry. Now, I think that this does not reflect any reluctance on the part of the sponsoring Government agency to move forward. I think it was a matter of the timing of the development, so I simply point out that we moved into that area at a time when we felt that the state of the art had advanced to the point where industry could make use of it effectively. It happened to be a fortuitous time to move in because industry did register an interest and did move ahead of its own volition.

Senator RANDOLPH. I have that product in my office. I may bring it down and place it here to show just what has been done.

Mr. GIFFORD. I thought this was a tangible evidence of technology application of a meaningful nature. This is the reason I alluded to this activity in my remarks this morning.

Senator RANDOLPH. Proceed, sir.

First, off the record.

(Discussion off the record.)

Mr. GIFFORD. Did I clarify the point?

Senator RANDOLPH. Yes.

Mr. GIFFORD. Fine. I will move ahead, then.

These programs, referring to the 12 programs I mentioned earlier, attracted more than 2,000 attendees in total. As a result of this effort, there was a great stimulation of private industry interest which prompted testing of samples of WPC by manufacturers of furniture, building supplies, flooring, sporting goods, textile bobbins, and others.

It is noteworthy that the South has the most advanced companies engaged in the production of this material on a commercial basis. Leaders in the field include American Novawood Corp., of Lynchburg, Va.; Louisiana-Radiant, Inc., of Baton Rouge, La.; Lockheed-Georgia Co., in Marietta, Ga.; and a new emerging company called

Gem Irradiated Wood Co., in Dothan, Ala. The technology was transferred to these companies, but the refinement of the process and resulting trade name items were achieved with private capital.

In addition to production of their own products, certain of these companies are supplying specification orders of WPC to firms such as Wing Archery, of Jacksonville, Tex., which is producing hunting bows; Hillerich & Bradsby, of Louisville, Ky., which is testing WPC in the famous Louisville Slugger baseball bats. Gunstocks are being tested by Reinhart Fajen, Inc., in Warsaw, Mo. Stanley Furniture Co., of Virginia, made some table tops and other products. This total effort involved effective cooperation among the Federal and State government, universities, and private industry.

Another project which I would like to mention quickly is a pilot pioneering effort which the Southern Interstate Nuclear Board carried out in West Virginia. In the area of applied science, we have determined that the most effective method for serving industries, and particularly small businesses, is to take technical information directly to them in a form which is digestible and understandable and which can be applied to their professional needs and environment, rather than having them seek out information in some regional or national center.

To test this approach more thoroughly, in cooperation with the Economic Development Administration, SINB undertook a small project in the Greater Kanawha Valley involving industries in and around Charleston, W. Va. We decided to compile systematically information on innovations, products and processes developed in the massive programs of the Atomic Energy Commission and the National Aeronautics and Space Administration, and attempt to apply them directly to this given industrial complex. We began with information and procedures dealing with several thousand potential applications on one hand and more than 100 industries on the other.

By a laborious and detailed process, we began to relate certain of these several thousand potential applications to the industries in the subject area which had a high degree of susceptibility for their use. In order to do this, we put together a team of experts with special capabilities to make this kind of selective judgment. We had an instrumentation specialist from New Mexico, radiation application specialist from Oak Ridge, nuclear equipment manufacturer from Ohio, an economist from South Carolina, a health physicist from Georgia, and a systems engineer from Virginia.

Senator RANDOLPH. Mr. Gifford, at this point, who paid for these men who came in, and what was the approximate cost of the project? Break it down for the subcommittee.

Mr. GIFFORD. Let me explain that we are a nonprofit organization. By "we" I mean the Southern Interstate Nuclear Board. We are, as I mentioned earlier in my testimony, privy to certain services, as any State government agency would be. But fortunately, we can draw on these people on an interstate basis.

As you have noted, we make use of specialists from outside of our region as well. Now, invariably, these people are willing to participate in projects of this kind on the basis of a modest honorarium and——

Senator RANDOLPH. You mean a consultant basis or a continuing basis?

Mr. GIFFORD. On a consultant basis. There are two major approaches, I think, that can be characterized here, Senator. One is that used by many research and development firms and laboratories and others which, of course, get excellent results, too. They attempt to have individuals on a permanent staff basis who can conduct surveys and projects and programs of this kind. The Southern Interstate Nuclear Board does not operate that way. We have a very small staff, but we bring into our program, on a selective basis, the experts that we feel have the special talent in those areas under immediate consideration.

Now, this may appear to be a "chancy" procedure, but it has worked out extremely well. We have had, I believe, out of more than 200 consultants, only three people who have declined participation. I function on the belief that I would rather have 2 days a month of an expert's time than 30 days of a lesser person's time.

Invariably, these people are willing to carve out enough time to help us, to give guidance and direction. We try to be judicious in the use of their time. We try to bring them in only at a point when they can make a maximum contribution. It may be 3 hours a week, or it may be 3 days a week if we are able to work that out. Invariably, they are willing to do this without interference with their primary responsibility.

Senator RANDOLPH. You will proceed. Help me to identify these persons and the source of the income and the overall cost.

Mr. GIFFORD. I think it should be recognized that these people do have full-time employment elsewhere and are frequently available only on the basis of their own time—it is sometimes vacation time that they give weekend work. These things they have done to help us, basically because they are interested in seeing these activities move ahead.

Additionally, we had the benefit of direct and extensive counsel from the Atomic Energy Commission in Washington and Oak Ridge, NASA technology utilization offices at Langley, Va., and Huntsville, Ala., as well as the State of West Virginia and the city of Charleston. In the identification process, we sought to determine any application, such as thickness gages, wear meters, testing devices, product instrumentation, and so forth, successfully used in industries throughout the United States which were similar to one or more of the industries under investigation.

In the final process, we came up with about 14 industries which had potential uses and fewer than 20 definite applications.

Senator RANDOLPH. I would like to ask you. Is that a sufficient number? Do you think this is good or bad? I wonder on the basis of the cost of the project, what you might comment on it?

Mr. GIFFORD. I think the investment to return ratio was extremely favorable. I mention elsewhere in this testimony that this project was funded in the amount of $15,000 by EDA and the Southern Interstate Nuclear Board contributed a like amount. So we were dealt with a $30,000 pilot project, which my testimony will reveal later, according to the Department of Commerce in West Virginia, produced about 75 new jobs. I think it is an extremely favorable ratio of return. I believe this will come out, Mr. Chairman, in my testimony.

Senator RANDOLPH. Thank you, sir.

Mr. GIFFORD. We then did in-plant surveys, meeting first with the management and then the production personnel of the installations. In addition, we had an instructional seminar for a select group of industrial people in the area. By walking through the plants and meeting with the individual company representatives, we were able to advise them specifically on types of products, application possibilites, estimated costs, and the commercial availability of instrumentation. It should be understood that we did not purchase any hardware for any of these companies but provided them with information and counsel.

Six months after this project, we made inquiry through the West Virginia Department of Commerce as to the results. We were told that the project, which was funded in the amount of $15,000 by the EDA and similar input by the Southern Interstate Nuclear Board, had produced industrial activities which resulted in approximately 75 new jobs. Incidentally, it also figured according to Gov. Hulett Smith, in his decision to form a science and technology unit in the West Virginia Department of Commerce.

In all of our endeavors, we have tried to carry out programs in a way which would meld the efforts and capabilities of the States and the Federal Government. Herein lies one of the major problems in our current technology utilization picture. The plethora of activity and program development principally at the Federal level poses the constant threat of operational impingements, concurrent jurisdiction, duality of control and performance, and outright usurpation.

It is significant that currently 34 Federal agencies are conducting approximately 457 programs for assistance to State and local governments, individuals, and private industry. Of this total, 22 agencies are currently sponsoring 109 programs specifically relating to business and industry. These statistics point up the increasing complexity of Federal-State relations and the growing need for interagency cooperation in providing services at the State and local levels. Some of these efforts have resulted in program officials from one Federal agency calling on a manufacturing firm only to be followed in succession by another group with very similar missions but without the benefit of coordination between the two. Sometimes this results in the small businessman being the victim rather than the beneficiary of well-intended program services.

There are a number of new and expanded Federal programs that have taken on great prominence in the technology utilization picture. Among these is the State Technical Services program under the U.S. Department of Commerce. In attempting to constructively evaluate this program, I point out that one of the deficiencies of the State Technical Services Act is the absence of authority to conduct long-range planning and research.

The State Technical Services Act was originally intended to provide just what the name implies—a State technical service. Under the original concept, the States were to receive block grants which could be applied as the State saw fit as long as the funds were used within the provisions of the act. Increasingly, OSTS has withdrawn this latitude in carrying out specific projects. Initially, anything up to $10,000 could be applied under the "block grant approach." That

figure has been reduced to somewhere in the neighborhood of $1,000. What has resulted is an inflexible line item control technique which produces a Federal technical services program using State employees.

The picture is further complicated by other unilaterally executed Federal programs. The massive technology utilization program of NASA completely ignores the States as functional entities. NASA deals directly with the university systems to the complete exclusion of State government. Approximately $5 million per annum is committed to the NASA program for identification, cataloging, abstracting, and disseminating technical information. It poses an interesting question as to why—despite the fact that this program is supported extensively by public funds—industries are required to pay from $500 to $20,000 a year for utilization of this data. The situation has the effect of pricing NASA technology utilization services out of the range of many small businesses and industries which can ill afford double payment. As a result, large companies are making use of this service; the small businessman is not. One steel company which had participated in the NASA technology utilization program at a cost in excess of $10,000 per year has told us that it withdrew from the program because it found in seeking information NASA required such detailed description of the problem that it was almost necessary to have the answer in hand before the question could be treated. The NASA abstracting and indexing system was not compatible with their technical information needs. They found that trade journals and general information services were more attuned to their information requirements and were considerably less expensive.

Senator RANDOLPH. Mr. Gifford, you raised a very important point there. I think it is a critical subject you are discussing. I wonder where you would suggest that we have a single point of contact of technology transfer—that is, the location of it in the Federal Government. Should it be within the Department of Commerce? Should it be within the Small Business Administration? I am not sure just where it should be, whether it would be a switching center or a central information bank, let us say. Discuss that, please.

Mr. GIFFORD. I do not know that I am really qualified, Senator. It certainly would be presumptuous of me to suggest that I have a panacea for this problem. I do not. I know that there are a great many responsible and dedicated people who are addressing themselves to this problem daily, not only in the Congress but in the agencies of the Federal Government. But it seems to me that the one ingredient that is sorely lacking is the measure of cooperation and coordination of these activities. The most well intended individual and the program which he represents can be more of an impediment than a help unless it takes into account parallel activities by other agencies and overlapping activities.

I do not know where this major control can effectively be located, unless perhaps it is somewhere at a level above any of the functioning agencies, perhaps in the scientific office of the President or in some composite group.

Senator RANDOLPH. Dr. Hornig's office? Would that be it?

Mr. GIFFORD. Possibly. I really have not attempted to form a definite position on that point. I offer this only in a rhetorical sense.

Senator RANDOLPH. Thank you very much.

Mr. GIFFORD. Another criticism that has come to us increasingly in recent months is that each of the seven NASA regional centers are competing for business essentially on a national basis, and the result is a confusion to the business and industry they contact. In some instances they have acquired manufacturing directories from the States which suggest that they contact business and industry direct in offering services to them. This probably happens because NASA is requiring the national regional centers to become self-sustaining. Industries have received a flood of promotional literature from NCR's such as ARAC, CAST, and KASC. There is a decided duplication of effort. The name "regional center" connotes a specific area of responsibility, and I would think that they should operate within those geographical areas and not compete for business nationwide.

As a point of program comparison, the seven regional centers of NASA are supported to the extent of $5 million per annum, while the appropriation for the Office of State Technical Services for fiscal 1967 was about $5.5 million. The STS program is designed to serve the 50 States and U.S. territories. There are numerous other sources which feed into this technology information mill including the Clearinghouse for Federal Scientific and Technical Information, the National Referral Center for Science and Technology, Science Information Exchange of the Smithsonian Institution, and others in lesser degrees, such as the Department of Agriculture, Department of the Interior, Department of Health, Education, and Welfare, Department of Defense, and, of course, the Atomic Energy Commission.

Senator JAVITS. I would like to just ask the witness how it happens that the name of the National Science Foundation is not found in this list? Do they not figure in this operation?

Mr. GIFFORD. Yes, they do, Senator, and the omission of the name is not an apocalypse. I did not include all sources. There are others.

It is interesting that you should mention NSF. We spent a good part of yesterday with representatives of the National Science Foundation in cooperative planning.

Senator JAVITS. I asked that question because their appropriation will be up in a few hours and an effort is going to be made to increase it. I think if there is any information bearing on this, we should know it.

Mr. GIFFORD. I think that the National Science Foundation has done excellent work in their programs. I am interested to see that they are also increasing their activities in the applied science field. But this, once again, adds to the problem which I have cited. It further heightens the necessity for coordination, because we have still another input into this area and, of course, it would behoove us all to try to work these things out on a cooperative basis.

The technical services program of the AEC has taken on a strong characteristic of exchange on a bilateral basis at a high echelon. It is more oriented to information exchange among the Federal agencies, major information centers and on an international basis than to the American businessman. They do an effective job in many areas in terms of horizontal transfer, but they have been less effective in vertical transfer. Despite this horizontal exchange experience, there is

an obvious need for more coordination among the Federal agencies in the execution of programs directed toward the State and local levels.

In attempting to serve the American industrialists by way of these programs, I would like to make another observation. We, of course, are greatly appreciative of the presence of centers of informational excellence in the same sense that one values the presence of a well-equipped library in a metropolitan city. However, the information centers have moved more and more to techniques of high sophistication using microfilm and computed tapes and related procedures for data compilation. Frequently this information is too obscure and too inaccessible for the small businessman. He can't afford the time to leave his business where he is worried about debits and credits, payrolls, and production schedules to travel to a regional center and ferret out information.

To further this analogy, perhaps we should consider, on behalf of the regional centers, some technique which could approximate the book mobile concept where potential users receive information in their own environment. This, in a true sense, is vertical transfer. The SINB approach attempts to establish cross-identification between the needs of the industry and the available information, then effectively relate the two by working from both ends of the spectrum.

It is interesting to me that in 1965 the Georgia Department of Industry and Trade directed a questionnaire to industrial firms, large and small, throughout the State, asking specifically if they were receiving technical information from NASA or the AEC. Of the 276 replies only four were receiving NASA or AEC technical information, and these were all large companies. A much larger number were receiving information by way of technical publications, trade magazines, and so forth.

Senator JAVITS. Would the witness yield for one question?

Mr. GIFFORD. Yes, Senator Javits.

Senator JAVITS. I am a member of the Appropriations Committee and will have to go to the floor in 5 minutes. Let me ask you this question: Do you think that the output of technical information to small business is sufficient, or do you think that more has to be done to bring about a situation where there is an input of the demands or requirements of small business, with technicians or professionals available to screen out of the available technology that which is germane to a particular industrial problem?

I ask that question because, having been a trade association lawyer for a good part of my life before I became a public official, I always found that technical assistance is one of the biggest needs of small business. You throw a mass of material at them and they are just too busy to really do much with it except in rare cases.

I ask, therefore, the question whether you consider it necessary, as an essential element of this operation, to amend the Federal law to provide for an input by small business as well as an output by the high level of R. & D. activities? Is this not really the missing link?

Mr. GIFFORD. I think that what is really the issue here, Senator, if this will answer your question, is that there is a gap between those who know and those who need to know. We do not have an effective

linkage. There is no absence of technology on the one hand and the need that manifests itself on the other. But there is a breakdown on the transfer of this technology in a digestible, meaningful form to the potential user. They do not have, as I have tried to illustrate here, time to go through large quantities of information, go through these reports, and attempt to identify a process which could perhaps be used, for example, in a rolling mill operation.

We found that by going in and predetermining the potential applications for these industries, then taking a group of people in, selected experts, and actually talking to the production engineer and saying, hypothetically speaking—I do not recall the exact references now in the study we did in Charleston—but hypothetically speaking, saying there is a firm in California that has an operation similar to yours and they are effectively using this thickness gage or this wearmeter; these are the estimates of cost and this is the experience they have had—it is almost a man-to-man, vis-a-vis type of transfer that has to be effected in order to reach small businessmen. Somewhere along the line, I would certainly hope that this committee could address itself to this missing link between a straight quantity of information on the one hand and the potential user on the other who is now being inundated with extraneous information.

Senator JAVITS. Will you tell us with specificity, therefore, precisely what has to be provided? Do we have to provide laws, do we have to provide offices, do we have to provide professionals in the service in order to establish this method for the small businessman? You should tell precisely what it is we must do.

Mr. GIFFORD. I think there has to be a distillation process of a more meaningful nature in taking this great quantity of technical information that is pouring out from these many sources and attempting to relate it. It is not sufficient to work from one end, simply have the information and pass it on to the industries and never know whether it has been received and applied or whether it is reaching them in a form that they can use. Neither is it sufficient to start from the other end and simply go forward to seek information.

There has to be an effective relationship from both ends of this spectrum working toward the center, which is the linkage between the source and the businessman. I think this has to be done primarily on the local level.

Senator JAVITS. Well, I would hope that you or other witnesses will tell us precisely how you want to do it. You still have not quite answered my question. But I am sure we will get it in the course of the hearings.

May I say before leaving that in my view, Senator Randolph is rendering the whole country a service by putting his finger on this major deficiency in the ability of small business to rival big business through utilization of the great progress in research and development. This is the whole answer to real breakthroughs by small business and the ability to keep its place in the American economic scheme.

Thank you.

Senator RANDOLPH. Thank you, Senator Javits, for your comment. Your knowledge in this field, your application to the study of these problems, I have had opportunity to know of this interest of yours.

I realize that your commitment is elsewhere at this time, but I know as the hearings move forward, you will try as far as possible to arrange your schedule to hear the witnesses enter into colloquy. I like the probing manner in which you have discussed these situations, which are fraught with some difficulty to answer perhaps too readily. But I am appreciative of the way you and Mr. Gifford discussed these situations today.

Mr. GIFFORD. Senator, before you leave, I might point out that this is not intended as a diatribe. I do not want to appear to present vilification or indictment of these programs. I am attempting here to point out some of the deficiencies. There are many good features of the program, obviously.

I would like to say that perhaps, without the benefit of some serious consideration of these problems in terms of exactly how we shall do this, I would be happy to assist Senator Randolph's staff or the staff of this committee, or any special group that might be involved, in attempting to arrive at an effective means for accomplishing just what we have discussed this morning. I would not like to attempt to offer, as I say, a panacea or a quick cure that we could all live with indefinitely. I think that that would certainly be more than presumptuous on my part. But I would be happy to work on a continuing basis with this committee in any way that I can to overcome this problem.

Senator JAVITS. Thank you.

Mr. GIFFORD. May I proceed, Mr. Chairman?

Senator RANDOLPH. Yes.

Mr. GIFFORD. Another problem which is a serious deterrent to effective technology transfer is the level of competence being demonstrated within the State application programs. There is a serious shortage of trained people at the State level with the knowledge and insight required to anticipate, project, and execute technology utilization programs for industry on a vis-a-vis basis. One possible solution to this dilemma would be the provision of professional institute training in the art and procedures of technology transfer. In looking further at the State Technical Services, it is apparent that the program has moved away from support in the managerial sciences to strengthen work with industries at the technical and production levels. Yet, effective programs at those levels can be greatly enhanced by earlier managerial endorsement and understanding. I hope this area will receive some additional attention.

Finally, I would like to mention the difficulty in financing high technology industries, particularly when they deal with specialized products and areas with long-range growth potential. It would seem appropriate that the Small Business Administration be brought into deliberations on this subject. Of course, this is not entirely a Federal problem. We recognize at the State level that there is frequent difficulty in having the banking institutions recognize, understand, and appreciate the industrial potentials of industry that deal with high technology and advanced science. We hope to combat this problem by increasing the number of special seminars for bankers and others.

In closing, may I observe that my remarks were not intended as an indictment or rejection of the Federal technology transfer programs, because there are obviously outstanding and productive features in

all the programs to which I have alluded. However, since these hearings were designed to identify problem areas and opportunities for increased effectiveness, I have elected to discuss some deficiencies of the programs and trust that my remarks will be accepted as constructive criticism. The SINB has enjoyed excellent cooperation from the AEC, Department of Commerce and other agencies at the Federal level. We feel that technology transfer is an area of great importance at the State and local, as well as the national level.

I was interested to observe in the representation of those scheduled to testify that there is no State government spokesman per se on the agenda. I hope the committee will be mindful of the strong interest of State government in this entire area, and will accept my sincere appreciation for the opportunity to appear here today in projecting the State and regional point of view.

Thank you, Mr. Chairman.

Senator RANDOLPH. Thank you, Mr. Gifford.

Mr. Rogers, do you have a supplemental comment?

Mr. ROGERS. Not specifically, Mr. Chairman. I would add that having had some experience with the science and technology application programs at a State level, I certainly agree with Mr. Gifford's comment that professional training is necessary in order to yield the most beneficial results and to transfer effectively science and technology.

I would further add that perhaps these programs at the State and local level must be a combination of technical information, educational seminars, demonstration projects, and conferences, where ideas can be discussed as well as where personal consultation may be offered to business and industry right in plant or at the industrial installation. I think that is about the only thing I would have to add, Mr. Chairman.

Senator RANDOLPH. Thank you.

Senator Baker, did you have any questions at this time?

Senator BAKER. Just one or two, Mr. Chairman, if I may.

Senator RANDOLPH. Yes. I am grateful for your presence today.

Senator BAKER. Thank you very much. I am grateful for the opportunity.

Senator Javits touched on a problem, it seems to me, Mr. Gifford, that has more than just primary significance. That is the creation of relations between the needs and the apparent demands of industry for utilization of the great profusion of new technology and organized, effective, coherent effort to meet those demands by Government agencies. Within the requirements of those two limits, you can point to an almost infinite number of additional problems, approaches, and ideas, because this is the essence and the basis of what we are talking about, it seems to me. One important and difficult task is trying to stimulate industry, business, and commerce to realize that certain technological innovations are available to them of which they are not aware or which they do not have the technical competence to grasp.

Does it not seem, then, that what we are asking is, in effect, the overall broad, historic, traditional question, how to best disseminate information, a question which has been with us since the first effort at scholastic undertaking was made many thousands of years ago? That is, in this case, how do we convince people, industry, business, or commerce that there is something new and different and that there are

techniques and developments which might be materially helpful to them in the exercise of their particular business or enterprise?

Is really not all of this entire conversation underlain by the question of education generally, technological education so businesses are made aware of the various new processes available to them?

Mr. GIFFORD. I think this is true. There is a definite need for preconditioning of a community to determine acceptance.

Senator BAKER. How would you go about making the country, and business in particular, more aware of the potential and the prospects for enhancing opportunities by technology?

Mr. GIFFORD. Let me try to answer you this way. I hope this is an answer. I am not trying to talk around you at all.

I think there has to be a greater sense of awareness on the part of the centers and the established programs that what they are doing is not an end in itself but a means to an end. I say this and use this reference advisedly, but I have the impression sometimes that these centers become so preoccupied with the task of getting information together that they lose sight of the fact that this is not their total mission, that they are getting information to put it into the hands of people who can use it.

Senator BAKER. Let me interrupt to say that is not always the case. As a matter of fact, there is some internal strength to be derived by the awareness that there are some centers of scientific inquiry used for the sole purpose of creating a base of scientific inquiry, without any practical application.

Mr. GIFFORD. I think this we accept in advance. I was addressing myself to technology transfer of a nature which we are discussing this morning. Of course, there are other programs which fall outside of this category and which are exactly as you described them. But for purposes of this discussion, I was dealing with some of the pragmatic problems of trying to get information to industry that can either improve its production schedule or do things faster, cheaper, or better. They can create jobs and additional or better products and a better method.

Now, we have worked very extensively with the Oak Ridge Operations Office of the AEC. We have just completed a series of six special conferences in Oak Ridge which attracted more than 1,500 select industrialists.

These were conducted as nuclear application opportunities and were cosponsored by the SINB and the Atomic Energy Commission. We covered such things as irradiated food; we had a special briefing for the coal industry; we had a briefing for the utility company representatives. The point I am making is that you have to deal with the decisionmakers in these companies to make them aware of the potentials.

Now, in this connection—I think Senator Randolph might be interested—we met with the National Coal Association president, Mr. Steven Dunn and representatives of the Bituminous Coal Research Institute up in Pennsylvania. We brought them to Oak Ridge for a prearranged meeting with Dr. Alvin Weinberg, Director of the Oak Ridge National Laboratory. We had some discussion as to the possibility of making use of the technical staff there to combat some of the problems of pollution.

Now, of course, the emission to the atmosphere of sulfurdioxide gas is one of the real problems of the coal industry, and it might be that we could use some radioisotope testing devices to determine the amount of effluence from these stacks, the amount of stack gas. We have been trying to bring together operational scientists, if I may use that term.

Of course, this in itself is not addressed directly to industry. This is a matter of working at a high level of scientific investigation. But these things do have practical results, we hope, and there are many programs which I think are in that category.

Senator BAKER. The point I am trying to make is simply this: I agree with you that there is a need for accelerated, as you put it, vertical transfer of information. I assume that means transfer between research institutions or governmental undertakings or private industry or the public generally. I am sure that is what vertical diffusion means.

Mr. GIFFORD. This is my term.

Senator BAKER. Fine. I agree with that. But on the other hand, I sense in your testimony and in some of the comments I have heard in the brief time I have been here that the nature of the scientific or technological inquiry should, in your view, be modified or changed in order to enhance that prospect or accommodate those requirements. With that I think I would take strong issue. I wonder, really, if our total job is not rather to preserve as nearly intact as possible the authenticity and independent justification of basic research or applied research, as the case may be, and then interpose a liaison between the scientific community and the consuming public or industry, by way of an informational service, rather than trying to impose this requirement on the installation itself, such as the Oak Ridge National Laboratory, such as NASA Huntsville, or others.

Specifically, I wonder if we really are not talking about the requirement, or the necessity, of making the public generally—and small business in particular—more currently aware of the brilliance of new technological advance so that small business and the public can make their own unique inquiries of an appropriate level of governmental function—that is, one designed to diffuse information?

Mr. GIFFORD. I think the problem, Senator, is the fact that a great many businessmen have no scientific flair.

Senator BAKER. But I think that you can popularize, if you will pardon the expression, scientific advance or technological advance to the point where even the most unscientific small businessman is intrigued with the idea, for instance, of being able to buy electricity at 1.2 mills per kilowatt instead of 0.8 of a cent per kilowatt. This is the sort of thing that translates into his frame of reference. You do not have to convince him that a breeder reactor or controlled thermonuclear diffusion is going to be the answer to that method of reducing the cost of manufacture of hardwood flooring. But if you show him how it impinges on an aspect of his production cost in lay language, I think it will have a significant impact.

Mr. GIFFORD. This is the point, Senator, and I think this is a missing link. I think we have to relate this technology in terms of the professional environment of the industry we are addressing ourselves to.

Senator BAKER. Are we not really, then, talking about communication—that is, the broad scale, popularized dissemination of technological advance to the public generally?

Mr. GIFFORD. Yes; I think so. But if you could just put yourself, for example, in the place of a small businessman in Elizabethton, Tenn. He may have fewer than 100 employees. I doubt seriously that he is going to be inclined of his own volition to go over to Oak Ridge or go down, perhaps, to Raleigh, N.C., where there is a regional center and attempt to identify information he might possibly use in his plant. Someone has to alert him to the fact that there is something that has potential for his plant, almost on a personal basis.

Senator BAKER. It seems to me, though, that this function might better be served, for instance, to use your example of Elizabethton, Tenn., by the Johnson City Press Chronicle or WCY–TV than it would by a person chronologically visiting this town and telling a businessman: "Here are some techniques you might be interested in." Once again I get back to popularizing the dissemination of scientific and technological information.

Mr. GIFFORD. Of course, there is always the value of stimulation. I might point out that there are many, many people who made contributions to the commercialization of nuclear power reactors. But I think one of the major turning points was the decision by the Tennessee Valley Authority. Because it is a public agency that made this decision, of course. This was, to me, the point at which the industry turned the corner.

Now, we have 16 major units that have been announced in the southern region in the last 22 months. This represents an investment of about a billion and a half dollars and it is a tremendously important input to our economy.

I was interested to observe in connection with the Duke Power Co. installation in upper South Carolina that Congressman William Jennings Bryan Dorn mentioned that that complex, of which nuclear energy is a principal component part, will produce about $24 million per year in taxes to the Federal Government and about $20 million to the State.

So these are tangible, measurable advantages that are coming out of the nuclear age. We could say the same thing about other things that are happening.

But I think the real problem here again is to relate this technology to a specific industry. I think instead of taking a broad shotgun approach, we should narrow our objective down. If we want to deal with the textile industry, let us deal with the textile industry specifically, or the wood products industry. We can talk to the furniture manufacturers about irradiated wood-plastics in terms of their interests, but it is almost necessary to talk on an individual basis to these companies in these fields, because their economic base is different, their production schedules and their products are different. So I think we have to reduce this to a more direct service rather than a general service.

Senator BAKER. Thank you, sir.

Senator RANDOLPH. Thank you, Senator Baker.

A final one or two questions. Mr. Gifford, is it necessary to have what I will call a face-to-face contact within a reasonable distance of

the user, or could we have some temporary transfer effect that might be accomplished from a more remote agency? What would you say? A central agency, perhaps?

Mr. GIFFORD. I do not think it is necessary to have an additional number of centers. I think we have a sufficient number of centers. I think the problem is getting the information from the center to the users.

Now, one technique that we have used that I believe works very well is to go through preestablished channels. If you want to reach the furniture industry, as I have outlined here, go through associations and try to set up a healthy contagion—in other words, deal through the association, they already have established membership, they know who the leaders are in their industry, who the forward thinkers are, the people who could use these innovations. I think the entrepreneurs are very important in this field.

I think we have to have this input in order to effectively use technology. But I believe that it might be well to try to work through organizations that are already in existence rather than forming additional organizations or additional programs.

Senator RANDOLPH. The last question, Mr. Gifford. In your Southern Interstate Nuclear Board, do you think there might be an extension to include non-nuclear as well as nuclear technology within your scope? In other words, why not contact businesses with a broad spectrum of, well, help rather than just this specifically?

Mr. GIFFORD. Well, it is interesting you should ask that question, because we have just held the Southern Governors' Conference. We have a nuclear space committee of that conference that is chaired by the Governor of Virginia. One of the items we have discussed more extensively, perhaps, than any other is this very point, what should be the scope of service of the Southern Interstate Nuclear Board.

When our organization was formed, no one really anticipated the nature of the impact or the magnitude of the impact in the space field, for example. But in 1962, the Governors passed a resolution directing our organization to provide service in our field to the space field, "of the kind and scope provided in the nuclear field." In the immediate discussion we were seeking an answer to the problems of oceanography, which is a subject that directly affects 11 Atlantic and Gulf coast States in our area.

I really feel that we are seeing a trend where we are moving more into a service of applied science and technology rather than just in the nuclear field.

Senator RANDOLPH. Off the record.

(Discussion off the record.)

Senator RANDOLPH. Thank you, Mr. Gifford, for your testimony and for the assistance and comment also of Mr. Rogers. Thank you both.

Mr. GIFFORD. Thank you very much. We will be glad to provide additional service as we can in this area.

Senator RANDOLPH. Thank you very much.

Mr. Cappello.

Mr. Cappello, if you will identify yourself and those with you.

STATEMENT OF STEPHEN W. KERSHNER, PRESIDENT, DELTA ELECTRONICS, INC., ALEXANDRIA, VA.; AND HENRY J. CAPPELLO, CONSULTANT, NATIONAL SMALL BUSINESS ASSOCIATION, WASHINGTON, D.C.; ACCOMPANIED BY ERIC P. SCHELLIN, ATTORNEY

Mr. KERSHNER. Mr. Chairman, we appreciate the opportunity of appearing before you today to make our view on technology transfer available to the Congress. I am Stephen W. Kershner, president of Delta Electronics, Inc., of Alexandria, Va., appearing on behalf of the National Small Business Association of Washington, D.C. I have with me today Mr. Henry J. Cappello, president of Space Recovery Research Center, Inc., Boca Raton, Fla., who also serves as special consultant to the National Small Business Association on patent policy matters. Also present with me is Mr. Eric Schellin, Washington patent attorney.

Senator RANDOLPH. Thank you, Mr. Kershner. I had said Mr. Cappello to start with, but I realize now that you are appearing as a team.

Mr. KERSHNER. Yes, sir.

Senator RANDOLPH. You may proceed.

Mr. KERSHNER. My comments are based on my experience for 20 years as a consulting engineer and for 5 years as president of a small electronics firm.

Problems of technology transfer from the standpoint of the small businessman have a number of aspects. These include: (1) the problem of becoming aware of new technology and its application to one's own small business, (2) the problem of locating sources of information on new technology, (3) the problem of obtaining, sorting through, and digesting technological information, (4) the problem of determining the economic feasibility of utilizing new technological innovations, (5) the problem of protecting one's own proprietary data and patents from infringement by other business and the Government, and lastly (6) the problem of direct and indirect cost to small business for obtaining technological data.

Delta Electronics has found the following sources of information on new technology to be useful: (1) professional and trade publications, (2) manufacturer's literature and application data, and (3) Government reports obtained from the Defense Documentation Center or the Commerce Clearinghouse. We have been using the services of the Defense Documentation Center for only a short time but have found it to be most effective in supplying report digests, bibliographies, and copies of reports.

One important problem of the present system is that our engineers have to review long lists of reports and digests in the hope of obtaining a few papers which are of real interest. One of the prime problems and considerations from the standpoint of small business is not only economy of expense in obtaining technological information but also economy of time. Time is probably the most valuable asset which the small businessman has. It is the one asset that he can least afford to waste on nonproductive endeavor such as wading through a mass of technological data. There are two important functions which

must be accomplished if small business is to obtain the benefit of any program of technology transfer. First, the material must be digested, assembled, and made available in such a form that a minimum of time and effort is required to locate those areas of technology which are useful to him; and second, it is almost imperative that some direct activity, either of Government or of private enterprise, be focused upon the small businessman, preferably in the form of an individual visit or an individual survey of his business, so that he is directly made aware of improved technology which could be of benefit to his business.

Senator RANDOLPH. At that point, you talked, Mr. Kershner, either of Government or private enterprise focusing on the small businessman. Now, how would that be paid for, sir?

Mr. KERSHNER. How would such a service be paid for? As I will state later in my testimony, it is my belief that the small businessman should and is willing to pay for this type of service. Undoubtedly, some support from the Government is required, but certainly not all of this service should be rendered or paid for by the taxpayer.

Senator RANDOLPH. The reason I asked that question is because earlier, on page 2, you talk about the present system and talk about the review of long lists of reports, digests, and that you hope to sort out a few papers of value. I am wondering if we should have condensation and whether we should sort and select reports, or would that put too much responsibility in the hands, perhaps, of some bureaucrats—let us use that word—who might not understand the needs of industry? Do you think this is a good policy?

Mr. KERSHNER. There is certainly an important need for this sort of sorting and production and simplification of the technical data that are available. But I think this has to be done by professional people, by and large.

Senator RANDOLPH. Do continue, sir.

Mr. KERSHNER. Many technically oriented small businesses, including Delta Electronics, have designed a line of proprietary products and developed new ideas which are protected by patents. The small businessman wants full and complete protection of such rights except where they have been obtained legitimately and fairly by the Government pursuant to an R. & D. or procurement contract. Accordingly, any legislation which may be enacted regarding technology transfer needs to be reinforced with positive prohibitions against the taking, under any guise, of privately owned proprietary data and trade secrets even for the otherwise laudable purpose of making new technology available to the general public.

Senator RANDOLPH. Mr. Kershner, do you have any examples of legislative deficiency which exists at the moment?

Mr. KERSHNER. No, sir; I do not believe I would. Mr. Cappello may.

Mr. CAPPELLO. I think one of the areas we are concerned about is 28 U.S.C. 1498, which permits the Federal Government, in connection with procurement of patented articles, to practically disregard the rights of small business. Now, there is the theoretical ability of small business to obtain compensation by taking their claim to the Court of Claims, but to the small businessman, this is no compensation at all, because ultimately it means that he has $50,000 in minimum legal fees on his hands and the prospects of recovery of that type of money on one of these things is almost nonexistent.

Senator RANDOLPH. That is helpful. You have brought it right to our attention. This will be studied by the subcommittee.

Continue, Mr. Kershner.

Mr. KERSHNER. We believe that another important requirement for a technology transfer program is to educate the small businessman as to the services which are available to him. This could be done by means of an aggressive public relations and advertising program. As a part of this effort, presentations should be made at seminars, and at trade and professional conventions. Personal calls should also be made to explain the services to individual businessmen.

An important limitation of the present system is that there is no single organization capable of providing a complete service in a given technological area. Such a service should consider information from all available sources; that is, governmental, professional, educational, and industrial. It appears that a small central organization should be established to coordinate the activities of several such technology transfer services, one for each distinct technological field.

Senator RANDOLPH. At that point, you say there is no single organization. What about the Small Business Administration? I am not certain that this covers what you are speaking of.

Mr. KERSHNER. I do not believe the Small Business Administration is primarily involved in the technology transfer field. It does provide some services.

I think Mr. Cappello has a remark.

Mr. CAPPELLO. In connection with the technological information that is provided by the Small Business Administration, Mr. Chairman, I believe that the program in its inception was a good one. There were many, many publications which were prepared by SBA which provided considerable guidance. However, none of these publications were developed to the extent that they would provide detailed, important information on new technology to the small businessman. Existing technology, basic industrial concepts, or establishing small businesses, these are covered. But new technology I do not believe is covered to any extent, nor is it the intent of the program to cover this type of technology.

Senator RANDOLPH. Thank you.

Mr. KERSHNER. I might add, sir, that my company has not benefited to any extent from any technical information made available by the Small Business Administration. It may be that we, again, are just not aware of what is available.

Since most of the technical and intellectual community looks to the universities as the fountainhead of creative intellectual endeavor, individual universities and colleges should be given the responsibilities of serving as a clearinghouse to compile up-to-date publications and data on one or more distinct technological areas within their special competence. Each such institution would then be the one place that businessmen, government officials, and other technical and educational institutions would look to for advanced information in that particular field of technology.

Senator RANDOLPH. Mr. Kershner, I wonder what we are talking about here in terms of miles. The need for proximity, you recognize that. Would you say it would be within 200 miles of the business? Would this be close enough?

Mr. KERSHNER. Well, if it were the University of California that happened to end up with space sciences technology, why, it may be 3,000 miles away.

Senator RANDOLPH. I realize that, but I am trying to think of those institutions that are closer at hand that can be helpful in business.

Mr. KERSHNER. Well, perhaps there could be an arrangement where the local State university, for example, or technical school could act as a transfer agent for the more distant university that specializes in the particular area.

Senator RANDOLPH. Thank you.

Mr. KERSHNER. Each university should have ready access to the existing governmental retrieval services and to all information available from professional and industrial organizations. A staff of scientists and engineers should be available to evaluate the information received and to provide consultation to businessmen when requested.

Although some Federal and State funding is no doubt required, we believe that small businessmen should, and are willing to pay for, the services they receive. For example, a charge should be made for all publications provided and for special consulting services.

Now, that is the end of my formal statement. I would like, if I may, to add the comment that on reading the subcommittee report, I was rather surprised to note the absence of any reference to the Defense Documentation Center services which are mentioned in my statement here, and which we have found to be very complete. This is information retrieval service.

Senator RANDOLPH. Off the record.

(Discussion off the record.)

Senator RANDOLPH. Thank you for bringing that comment up, especially the failure to mention the work within that agency. I shall check that out myself. I am sure it was inadvertently done, because it is of value, as you indicate.

I would like to recess for just 2 minutes, please.

(A brief recess was taken.)

Senator RANDOLPH. On the record.

Mr. Cappello, would you speak, sir?

Mr. CAPPELLO. These remarks, Mr. Chairman, are to supplement those of Mr. Kershner. I shall try not to cover any of the same ground, except to perhaps amplify and expand on some of the important points he raised.

Most small businessmen, in our view, are opposed to the establishment of any new Federal agencies that would impinge in any manner upon their firm's operation or their cost of doing business, no matter how desirable such programs might otherwise appear. Such programs should be handled, where possible, by the business community itself or by private organizations that are directly responsive to business requirements and completely independent of Government control or influence. Undertaking of vast new programs of technology transfer by the Federal Government——

Senator RANDOLPH. Where would we draw the line there? You say vast new programs.

Mr. CAPPELLO. What I specifically have in mind, Mr. Chairman, is that we would not favor any program of establishing a new Federal

agency to coordinate, duplicate, and just have another superstructure over what exists now, because this would be wasteful and accomplish nothing as far we are concerned.

Senator RANDOLPH. You think now we are top heavy, overlapping, hodgepodging, and hit and missing?

Mr. CAPPELLO. I think the very excellent report which your staff prepared indicates this very clearly. I think we need to reduce the duplication, consolidate and place many of these functions in the hands of private agencies, which tend to look at a dollar a little more closely when they prepare a program of research or transfer of technology.

Undertaking of these types of programs even by State and local governments is unnecessary, uneconomical, and in most cases would be wasteful of the taxpayers' dollars.

We have some suggested reorientations for the Office of State Technology Services, which was established in President Kennedy's administration under Public Law 89-192. I think it is of considerable significance that of the fiscal year 1966 appropriation of $3.5 million for OSTS, administrative services and planning grants absorbed $1,431,101, or approximately 41 percent. This is understandable because there are 53—54 if OSTS is included—separate governmental agencies providing planning services.

The present concept leads to a fractionated, diffused, and highly duplicative effort and fails to utilize available Federal funds in a way that contributes to dissemination of technical information to small business.

Senator RANDOLPH. At that point, if not in every State, how many could we have and where would they be located to do a better job?

Mr. CAPPELLO. What we are suggesting is not that every State should not have a program. We are suggesting that the OSTS approach wherein it contributes to the administrative overhead of these programs is not a correct one. We think that these Federal funds could better be utilized to supplement existing programs at the State and university level. That is where we would prefer to see this money spent.

Senator RANDOLPH. Mr. Cappello, you mentioned these universities and colleges being given the responsibility of a clearinghouse function, compilation of publications and so forth. I wonder if universities know what the day-to-day needs of business are in this country?

Mr. CAPPELLO. I think they know them as well as most of the Government agencies who are now attempting to provide technology transfer services, and certainly, I think that the average small businessman would look more directly to a university than he would to NASA or national defense agencies, or these other esoteric Government functions with which he has little connection and very little relationship.

Senator RANDOLPH. Would you make any comment on what I said in my opening statement about the so-called bigger segments of industry?

Mr. CAPPELLO. It is my opinion that large industries, in general, have good capability and organization to keep abreast of new technology of particular interest. I am sure that even some of the largest industries would benefit from a program of technology transfer which sorts out and rejects some of the vast amount of duplication or just

plain garbage which is being generated in ever-increasing amounts by Government and private research and development activities. Reinventions and rehashes of existing technology is a byproduct of our scientific community's obsession for "getting something published." I believe that this is generally recognized as a major problem by all scientific researchers.

We believe that in setting up a program with individual universities and colleges, individual universities should be given the responsibility of serving as a clearinghouse and compiling publications and data in one or more distinct technological areas within their special competence. Each such institution would then be the place that businessmen, Government officials, and other technical and educational institutions would look to for advanced information in that particular field or technology. Each such institution would be responsible for at least two publications—one a yearbook which, in narrative form, sets forth in reasonable detail all recent accomplishments in the selected field of technology and secondly, a codified service similar to looseleaf services provided by the Bureau of National Affairs, Commerce Clearinghouse, and Prentice-Hall, wherein abstracts and citations are compiled on a continuing basis.

Senator RANDOLPH. Now, you got into the consultant service here. I am moving along quickly. What are you thinking of, the subsidization of existing consultants, research institutes, contract laboratories? What are you thinking of?

Mr. CAPPELLO. We are thinking of expanding the expertise in the existing State Technical Services organizations; such organizations as State industrial development commissions. There are innumerable State agencies which purportedly serve small business interests. They are known by many different names. We feel that a coordination of these programs perhaps with Federal guidance is what we need.

The Small Business Administration might be a good focus for this sort of thing.

Senator RANDOLPH. You talked about technical foundations and associations as information. You said that they should be encouraged. Now, this might be contrary to the private sector feeling of self-supporting information. Is that right?

Mr. CAPPELLO. Yes. We believe that there are many foundations and associations now engaged in abstracting technical publications, that these functions could be tied in with university services. Perhaps duplication of staff could be eliminated. Some of the research activities which are now being performed by the association and foundation staffs could be turned over to the universities, and then it could be done more efficiently and with less expense and still have the service provided by the publications that are put out by the associations and foundations.

Senator RANDOLPH. Mr. Cappello, you have mentioned the best brainpower of the country here. What do you think about the R. & D. brainpower? Is this sufficient, or are you saying that this is deficient?

Mr. CAPPELLO. In the R. & D. area, we feel that small business, just by its nature, has an abundance of brainpower which is now not being utilized in R. & D. programs. I think it is one of the characteristics of the successful scientist and engineer that very often, he wants

to go out and start his own small business and incorporate the fruits of his own knowledge and achievements in his own business. I think Mr. Kershner is an example of this sort of thing. Many members of our association have had such foundations for their business.

Senator RANDOLPH. Mr. Kershner and Mr. Cappello, I am thinking now and I am concerned, and I am sure that you have good reason to make the statement, but you say bids are solicited, usually from large businesses, words to that effect, and the small business firm rarely hears of the subsequent procurement; he is not given a chance to sell his product to the Government. Can you document that? If not at this moment, perhaps at a later date?

Mr. CAPPELLO. I have several examples of that which I would be very happy to provide.[1]

Senator RANDOLPH. That would be helpful to the subcommittee, because this is a concern of ours. This is a concern of the Select Committee on Small Business, I can assure you. When you get into the discussion of patent legislation, I would like to suggest it here, very frankly.

Do you have any further comment?

Mr. CAPPELLO. Well, this just about completes the information I wanted to bring to the attention of the committee.

(The prepared statement of Mr. Cappello follows:)

STATEMENT OF HENRY J. CAPPELLO, CONSULTANT, NATIONAL SMALL BUSINESS ASSOCIATION

These remarks are supplementary to those presented to the Committee today by Mr. Stephen W. Kershner.

Most small business men are opposed to the establishment of any new federal agencies that would impinge in any manner upon their firm's operation or their cost of doing business, no matter how desirable such programs might otherwise appear. Such programs should be handled, where possible, by the business community itself or by private organizations that are directly responsive to business requirements and completely independent of government control or influence. Undertaking of vast new programs of technology transfer by the federal government, or even by state and local governments, is unnecessary, uneconomical, and in most cases, would be wasteful of the taxpayers' dollars.

This is not to say that government does not have a valuable function to perform. Certainly the government must assemble and make available to the general public the fruits of the vast activity in research and development which is being conducted at such tremendous costs to the taxpayers. Congress has already enacted legislation providing for a wide range of programs and services aimed at the collection and dissemination of technological data.

While we find the concepts and procedures involved in the existing programs, by and large, to be sound, it is our feeling that very little of the technology which is developed, described, correlated and disseminated today by the federal government is either readily available or useful to small business. Much of this information (for example that compiled in NASA reports) is so voluminous and so disorganized that the average small business man simply does not have the time to dig for that small segment of technological information in a particular area that might be of interest to him.

We have reviewed in some detail the reports and procedures of the Office of State Technical Services (OSTS) that was established to implement the procedures of the State Technical Services Act of 1965, (Public Law 89–182), because in our opinion this Act was intended to accomplish the goal of technology transfer implicit in your Committee's present study.

It is of considerable significance that of the fiscal year 1966 appropriation of $3,500,000 for OSTS, administrative services and planning grants absorbed

[1] Retained in committee files.

$1,431,101 or approximately 41%. This is understandable because there are 53 (54 if OSTS is included) separate governmental agencies providing planning services. The present concept leads to a fractionated, diffused and highly duplicative effort, and fails to utilize available federal funds in a way that contributes to dissemination of technical information to small business.

We suggest re-orientation of this program as follows:

1. Most of the technical community views the universities as the fountainhead of creative intellectual endeavor. Individual universities and colleges should be given the responsibility of serving as a clearing house and to compile publications and data in one or more distinct technological areas within their special competence. Each such institution would then be the one place that business men, government officials, and other technical and educational institutions would look to for advanced information in that particular field of technology. Each such institution should be responsible for two publications; one, a Yearbook which, in narrative form, sets forth, in reasonable detail, all recent accomplishments in the selected field of technology; and, two, a codified service, similar to looseleaf services provided by Bureau of National Affairs, Commerce Clearing House, and Prentice-Hall, wherein abstracts and citations are compiled on a continuing basis.

The allocation of responsibilities for specific fields of endeavor, we believe, should be made by a commission of educators sponsored by and funded by the federal government. Money now being used for state planning services could be used for this purpose. Legislation should authorize and require all federal agencies which are now compiling technological data to make this data available to the responsible universities in each area of technology.

2. We believe that State Technical Services should be expanded to render consultant services. Under such a program qualified individuals employed by the states would directly contact a small business, study it, and then advise it of new technology that could improve process, product, or business organization of the small business.

3. State Industrial Development Commissions or similar organizations should be provided the matching funds which the Office of State Technical Services is now providing to them, but these funds should be earmarked largely for direct consultant services to small business.

4. For technology transfer purposes, matching funds from the federal government should be made available to institutions of higher learning to supplement funds received from other sources. Such sources would include state governments, private citizens and business, and technical foundations and associations. The latter should be encouraged to avail themselves of the resources of institutions of higher learning instead of duplicating them with their own technical services, publications and staffing.

There are three areas of technology and proprietary development in connection with technology transfer that are of particular concern to the small business man.

First is the long range requirement, which we have expressed on several occasions to the Congress on behalf of the NSBA, of a program of Research and Development set-asides for small business primarily in connection with defense and NASA activities, but also with activities of other agencies of the government. Under such R&D set-asides, the talents and abilities of vast numbers of small businesses could be directed toward the solution of many, many technical and scientific problems which face the government. The failure of the government to provide a substantial amount of R&D work for small business has been detrimental not only to the interest of small business in general and to the growth (and in some cases the survival) of technologically-oriented small business, but, in the larger sense, has been detrimental to the country as a whole because it has elminated a source of some of the best brain power in the country.

Where the technical competence of small business is utilized today in R&D, usually there is neither proper compensation nor concern for its proprietary rights. Illustrative of this is the use of purchase order contracts for pilot procurements of specialty items. The bait of potential large volume purchases is dangled before a creative small business firm with proprietary know-how to develop prototypes to meet specialized government needs. These purchase order contracts are usually performed at a loss by the small business firm. The government takes the proprietary know-how and product of the small business (including specifications, drawings, and manufacturing processes). With a minimum expenditure

of money and effort the government then prepares an "Invitation for Bid" based on the successful accomplishments of small business in the pilot project. Bids are solicited usually from large business only. The small business firm rarely even hears of subsequent procurements. Rarely is he given a fair opportunity to sell his product to the government. If the government is going to take this R&D for its own purposes, it should pay for it. A set-aside program is a necessary first step. It would insure that at least part of this R&D is paid for.

Secondly, small business as well as business at large urgently needs a definition of the government's rights vis-a-vis business in connection with patentable inventions developed with government R&D funds. The time is long overdue for some sort of overall patent policy legislation to be enacted by the Congress. The guidelines established by President Kennedy for determining rights to patentable R&D inventions are not uniformly administered by the departments and agencies of the government. Unfortunately, the prevailing attitude of government representatives, lacking any strong positive legislative guidelines, is to cut down on the rights of private industry rather than to give it entitlement to R&D inventions which would stimulate the marketing of new and improved products. Small business should be given by law the first option to utilize commercially those inventions made possible by federally-financed R&D.

Our third area of concern, one that has plagued many of our members in government procurements, is appropriation by government of proprietary data or infringement by government of patents developed solely with private funds. A frightening drive—with participation by most government technical and procurement personnel—to appropriate private intellectual property without fair compensation whenever and wherever it is possible, is gaining considerable momentum. Any legislation that may be enacted regarding technology transfer needs to be reinforced with positive prohibitions against the taking, under any guise, of privately-owned proprietary data and trade secrets. The laudable purpose of making new technology available to the general public does not—cannot—justify such conduct by government.

Many creative small businesses, having had disastrous results in trying to protect privately-developed patented inventions from infringement in connection with government procurement, have now undertaken to protect their intellectual property as trade secrets and by the route of classifying technical design data as proprietary data. They refuse to provide their intellectual property to the government unless the government pays for it. The reaction of government officials in many cases is to attempt to appropriate this private proprietary data by subterfuge of procurement technicalities without taking licenses or paying for this data. Small business cannot afford any legislation which might further encourage these self-righteous appropriators.

Mr. CAPPELLO. I would like to suggest that Mr. Schellin, whom I asked to come here with me this morning, might have some comment, particularly on abstracting, which might be of value to you.

Mr. SCHELLIN. Mr. Chairman, my name is Eric Schellin. I am a patent attorney in Washington, D.C. I am senior member of my firm.

You might say that I am engaged in technology transfer on a day-by-day basis, doing professional work for approximately 100 patent attorneys who are in private practice across the country, 100 patent attorneys who are working for corporations as in-house counsel, and also engaging in professional matters for approximately 25 research directors in various corporations, large and small, all the way from the smallest up to almost the biggest.

Having been engaged in this particular specialized field here in Washington and being associated with the National Small Business Association and Mr. Cappello, I have a few comments. I was not going to say anything this morning, but listening to the other gentlemen speak, I made a few notes here that I can go into very quickly. I think it would be apropos of what you are attempting to do here.

Technology transfer is supposed to do one of two things, and sometimes both. This is my own estimation from my own experience. First, it is to avoid a repetition of a prior effort. By that I mean if someone

else develops an invention, let us say, that person wants to know whether it has been done before. So if he continues in the effort and he fails due to the fact that he comes too late into the marketplace, it is going to hurt the American taxpayer, because he will write it off as a loss. Therefore, we want to encourage the businessman to make a profit, so he should be first.

I have occasion to use many of the facilities available in the Washington area which will cut off repetition of effort. For instance the Patent Office Scientific Library, the Patent Office classified patents, the Library of Congress, the Department of Agriculture Library. A very interesting source is the National Medical Science Library, which I had occasion to use recently. I think it is a tremendous institution. A professional matter came in from the prime contractor of the Apollo project. The Apollo project, as you know, is funded by the U.S. Government. All of us are looking for fallout from the Apollo project.

Working in the ecology of the system of the astronauts who will be in the Apollo, we came across a new compound which we found had certain characteristics for remission of cancer. The Apollo project prime contractor would have to decide what to do with the compound. They could invest more money into this in further development and maybe go into the pharmaceutical field or give it over to the pharmaceutical concern.

Before making a decision, they sent the matter to me. I investigated by using the facilities of the National Medical Science Library, and was informed through their wonderful computerized system that in fact, the compound had already been used for this particular purpose, did in fact have the remissive characteristics, but the side effects were unpleasant, thereby indicating that no other effort should be made in connection with this drug.

If the first point is to prevent repetition of an effort already accomplished by someone else, then the second point for the sophisticated businessman—and the businessman is extremely sophisticated these days—then he is interested in obtaining information to enable him to move into a new field, utilizing the information already available as a basis. In other words, he is going to take this information, as Mr. Kershner has in the particular operation he is interested in; that is, antenna arrays, take this information, build on it by innovation, and make advances.

You said in the beginning, Senator Randolph, that the large corporations are self-sufficient in their information capabilities, their retrieval capabilities. I have yet to meet a corporation that is fully self-sufficient.

Senator RANDOLPH. I did not say they were self-sufficient; I said apparently they felt, some of them, that they are self-sufficient.

Mr. SCHELLIN. Well, they are not and most will sooner or later realize this.

Senator RANDOLPH. As we have studied this subject, that is what I was directing the question to, of Mr. Cappello and Mr. Kershner.

Mr. SCHELLIN. Yes. Well, from my own experience, they are not self-sufficient in new areas into which they want to make progress. In the particular area in which they are manufacturing they, of course, are experts, since they subscribe to all of the trade articles and journals.

But if they are going to go into a new area—let us say a soap manufacturer wants to get into the mouthwash business, he does not have the expertise in that field, the background. He acquires it and, of course, by literature searching, patents are available as a source.

I would like to make a further comment, specifically with reference to an organization with which I am familiar, and that is the Chemical Abstracting Service of the American Chemical Society. It is a private, nonprofit organization. I feel as Mr. Cappello touched upon, that this particular type of effort should be duplicated in other fields, that perhaps as many as 12 centers should be established. The 12 centers would be in association with the universities so that universities providing the services would become experts in the particular technical endeavor. These 12 fields might be tied in with the Patent Office groups of technical endeavor. Specifically, they might be further tied in with a classification system which is somewhat—also the way the Patent Office classifies its own patents.

I have here a manual on classification entitled "Development and Use of Patent Classification Systems, U.S. Department of Commerce." It is only $1.50, and it sets forth the basic concept, the theory behind classification of inventions, and of technology geared to patents. If this type of manual were also used and geared to technological information, which would be the output either from R. & D. effort of the U.S. Government, R. & D. effort of State governments, and the R. & D. effort of private industry, I think that this information would then be made available to the 12 centers, let us say hypothetically, and based on their expertise in a particular field, they would then abstract this information, put it out in an abstract service, just as the American Chemical Society does with their Chemical Abstracting Service.

They are having a hard time these days getting people to run the abstracting service because of funds and because they cannot provide enough. In conclusion, technology transfer can be accomplished with the Patent Office system making available patents which are published, with the Official Gazette, with the Chemical Abstracting Service of the American Chemical Society, and with the new endeavors leading to a number of centers for abstracting information. The abstracting services that are established should be funded partially by the Government, should be partially paid for by those using it on a subscription basis. They should advertise its availability so that the businessman knows that this abstracting service is available. It can be used in the schools so that the future businessman, when he goes into the business world, is aware of this abstracting service, just as I was, when graduating as a chemical engineer from a university, familiar with the American Chemical Society Chemical Abstracting Service.

Thank you for the opportunity to provide my comments.

Senator RANDOLPH. Thank you very much for your contribution to our discussion this morning.

This will conclude our hearing today. We are going over to next week, Tuesday, September 26.

Thank you, gentlemen.

(Whereupon, at 12:05 p.m., the subcommittee adjourned until Tuesday, September 26, 1967, at 10 a.m.)

[illegible]

[illegible]

[illegible]

Thank you for the opportunity [illegible] our comments.

[illegible] Thank you very much [illegible] this morning.

This will conclude our hearing today. We are going over to next week, Tuesday, September 26.

Thank you, gentlemen.

(Whereupon, at 12:17 p.m., the subcommittee adjourned until Tuesday, September 26, 1967, at 10 a.m.)

TECHNOLOGY TRANSFER

TUESDAY, SEPTEMBER 26, 1967

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE AND TECHNOLOGY
OF THE SELECT COMMITTEE ON SMALL BUSINESS,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10:30 a.m., in room 1202, New Senate Office Building, Senator Jennings Randolph (chairman) presiding.

Present: Senators Randolph and Javits.

Also present: Blake O'Connor, professional staff member; Daniel T. Coughlin, minority counsel; and Richard A. Carpenter, Legislative Reference Service, Library of Congress.

Senator RANDOLPH. Good morning, ladies and gentlemen.

We resume our hearings on transfer programing within the area of technology.

Our witnesses today represent various institutions engaged in this process. They are, I think, important agents, linking the sources of technical information to users in the industry and in public programs.

Mr. Danilov, would you come first, please.

Let's have all the gentlemen, then, Dr. Kimball, Mr. Hobson, and Dr. Weimer, come up. We will ask you to sit as a panel. And I think that we could allow you—and I would suggest, and of course, only suggest—approximately 15 minutes each for making your formal statements. And then we can have discussion.

And I do want you to realize that you can give to the subcommittee additional information which will be included as a part of the printed record. You know as well as your chairman that there is value in material which you can supply which the public should read. But within the time limitation here, it is difficult for us to delineate it.

So, Mr. Danilov, will you begin as the first of the panelists.

First, will you identify yourself for the record.

STATEMENT OF VICTOR J. DANILOV, EXECUTIVE VICE PRESIDENT, INDUSTRIAL RESEARCH, INC.; AND EXECUTIVE EDITOR, INDUSTRIAL RESEARCH AND OCEANOLOGY INTERNATIONAL MAGAZINES, BEVERLY SHORES, IND.

Mr. DANILOV. Victor J. Danilov, executive vice president of Industrial Research, Inc., and executive editor of Industrial Research and Oceanology International Magazines.

I appreciate the invitation to appear before this subcommittee to present my views on the increasingly important subject of technology

transfer. I was pleased to learn that you were examining the Federal Government's role in the transfer process and that you were seeking ways to make the transfer more effective.

As the editorial director of two technical magazines, I have been intimately involved in at least one aspect of technology transfer for the last 5 years. Prior to that, I observed or participated in various other aspects of the process for 15 years as a newspaperman, a college teacher, and the public information officer at a university, a technological institute, and a nonprofit research organization.

I will make my comments relatively brief. However, I would be glad to elaborate on any points of interest to you following the presentation of my statement.

There is not a question, in my mind, of the importance of technology transfer to the Nation's economy, industry, and welfare. Significant contributions have been made in the aerospace, electronics, metalworking, nuclear, agriculture, and other fields. Nearly every industry has benefited—to some extent—from the discovery and application of new knowledge gained through federally financed research and development programs.

In addition to spawning industrial innovation, technology transfer assures maximum utilization of the Federal R. & D. investment and provides another means for furthering the Nation's economy and welfare.

I believe that technology transfer is a logical extension of the Federal research and development program, and that every effort should be made to improve the effectiveness of such activities.

Those Federal agencies that have technology transfer programs are to be commended. Their pioneering activities have demonstrated the value of technical transfer, and have pointed out the promise of a close working relationship between Government and industry.

However, like most of you, I am concerned about the proliferation and duplication of transfer programs. I also have the feeling that some of the agencies are more interested in justifying their appropriations or expanding their spheres of influence than they are in transferring technology.

Senator RANDOLPH. May I interrupt at that point?

I have felt that to a degree we are guilty within the Federal structure of a Hydra-headed government. I have felt that for a long while. I remember I expressed that in 1930 when I first ran for Congress. Of course, then I was outside hoping to get inside, and naturally I was very critical of the agencies of the Government and the overlapping of the work that was being done.

I imagine that rather than diminishing overlapping we have had an increase, because of the very bigness of Government itself, reflective of the bigness of our country and its problems.

What would be your comment? You have mentioned it here in another way, but essentially we are thinking of the same subject.

Mr. DANILOV. I believe that this trend will continue indefinitely as the Federal Government and the national needs expand.

As it pertains to technology transfer, I am not critical of the efforts to disseminate technological knowledge, but rather the various mechanisms for achieving that goal. There are at least a half dozen major pro-

grams in technology transfer. Each is trying to do essentially the same job as it pertains to the agency's activities.

Senator RANDOLPH. I agree with you, Mr. Danilov.

Mr. DANILOV. I am merely saying that there should be some way to coordinate these transfer activities. In my presentation, I will offer what I think is a suitable plan to accomplish this objective.

Senator RANDOLPH. I am not going on to another subject, Mr. Danilov, but I think the biggest problem, and the one which we have not licked in our antipoverty program, is that that program has bogged down, at least in part, because of lack of coordination. And I think those that support it most actively understand that this is a deficiency within the program. But it seems, from the very nature of the problems that we are attempting to face and lick, at least in part, that this is a penalty that we are paying.

I wonder if somehow or another we can benefit by what you are saying and perhaps suggestions that you have.

Mr. DANILOV. Even more important is the fact that technology transfer has not even approached its potential. We have much to gain, as a Nation, from a better coordinated and more effective system of passing along Government-funded technological information that has application in industry.

Although the danger always exists that Government may usurp the free enterprise initiative of industry, I do not believe such fears are justified in this case. Rather than being a deterrent to private initiative, I see technology transfer serving as a stimulant to private investment and industrial innovation.

Before offering my suggestions for implementing technology transfer, I would like to comment briefly on some of the proposals under consideration:

1. Although I favor greater coordination of the Government's technology transfer program, I am opposed to the centralization of all such activities in a single superagency. I do not believe it is necessary nor practical to consolidate transfer operations under a new or existing Government umbrella. However, I do realize the necessity for some administrative coordinating device.

2. The most efficient way to handle the mass of data involved in technology transfer probably would be to have a single information center in Washington or at some other appropriate location. Such a center may be necessary for compiling and cataloging the data from various sources, but experience has shown that a distant clearinghouse is likely to be ineffectual in the diffusion process. The distribution point must be convenient if it is to be utilized by those who need the information the most.

3. At the other extreme is the proposal to have regional or State dissemination centers handling the full range of transfer information. In theory, such a system has much to offer. But it appears to be impractical to expect each center to be a fountainhead of knowledge in all fields and to have a sufficient number of specialists who can communicate with industrial, scientific, and technical people in those fields.

4. Although I realize the desirability of having regional or State centers located in the so-called have-not areas, I believe the primary

aim of the technology transfer program should be to assist existing industry to improve and expand by capitalizing on such knowledge. This means that any network of dissemination centers probably should be placed principally in those areas where industry is located.

5. There undoubtedly are advantages to utilizing universities, nonprofit research institutes, and Federal contract centers at dissemination points for technology transfer. But I believe it would dilute their purposes and/or the transfer program to have them serve as transfer agents. I would much rather see the dissemination centers function independently of such institutions, although they probably should be located physically at or near such facilities.

6. I think it is a mistake to assume that the mere establishment of one or more coordinated transfer centers is sufficient to correct the problem. As we all know, there are many people who are to busy, too uninformed, or too afraid to take advantage of worthwhile activities. Therefore, I believe that the dissemination centers will have to have adequate staffs of competent field representatives who have almost a missionary zeal for carrying new knowledge to needy industries.

7. Along this same line, some provision should be made in the technology transfer program for educating industry to the advantages of utilizing new information, products, and techniques emanating from Government-financed research and development. Besides being physically convenient, the transfer must be meaningful to and wanted by the recipients. Any technology transfer program will fail unless industry makes use of its services.

It is against such background that I would like to recommend a novel approach to the technology transfer program. It might be called a "technological partnership," involving not only the Federal Government and private enterprise, but also such instruments of communication and progress as trade associations, professional societies, universities, and perhaps technical publications.

I am proposing a system that is much broader in concept than most transfer plans currently under discussion. In addition to facilitating technology transfer, the plan is designed to assist with the solution of industrywide research problems and to spearhead the overcoming of technological obsolescence and indifference on the part of companies and individuals.

The proposed program builds on the successes of the past and the needs of the future. The main features of the plan are as follows:

1. Responsibility for coordinating the technology transfer and related activities would be assigned to one agency—probably the Department of Commerce, which has a mandate to assist business and industry. All other Federal agencies would continue to be involved in technology transfer, but the nature of their activities would be modified to meet the specific needs of the various industries.

2. Industrywide councils would be established for each of the principal industries. These councils would consist of representatives from Government, industry, universities, and appropriate trade associations and professional societies. The councils would have three primary functions:

(a) They would determine the general nature and form of technology transfer that would be most helpful to their respective industries.

(*b*) They would be responsible for the operation of one or more industrial research and information centers serving their respective industries.

(*c*) They would decide what research should be conducted at the centers and would have the authority and funds to sponsor contract research with outside organizations.

3. There would be at least one industrial research and information center for each major industry. These centers would be financed largely by the Federal Government, but would receive some support from industry through fees for services. In most instances, the center would be located at or near a major university in a region where there is a large concentration of companies in the industry. If all of the principal industries were to have such centers, it probably would take about 20 to 25 centers to accomplish the purpose.

4. The industrial research and information centers would have a number of functions:

(*a*) They would serve as technology transfer agents for their respective industries. They would receive and store all data transmitted to the various centers, but they would disseminate only those portions that are applicable to the industry they are serving.

(*b*) They would diffuse information of use to their respective fields by preparing periodic and in-depth reports, sponsoring meetings and short courses, cooperating with trade and professional groups, conducting literature searches, answering inquiries, advising needy companies, supplying information to trade and professional magazines, and having specialists make personal calls on the companies in their industry.

(*c*) They would conduct research on the major problems facing their industry and explore new areas in which the products and processes of the industry may be utilized. In doing so, they would be careful to avoid competitive research and not to duplicate research being conducted in industrial or trade association laboratories.

(*d*) They would coordinate and monitor the research contracts awarded by their respective industrial councils.

(*e*) They would work with universities, professional societies, and accrediting groups in updating the undergraduate, graduate, and postgraduate offerings of colleges and universities in pertinent scientific and technical fields.

5. The support of trade associations and professional societies would be solicited in planning and implementing nearly every aspect of the program. In this way it is hoped that these groups will use their influence in convincing both companies and individuals to utilize the services of the centers.

As you can see, this five-point program has a dual purpose—to facilitate the transfer of Government-funded technology and to carry out research, education, and related activities on an industrywide basis. In both instances, the ultimate goal is the same—the acceleration of industrial innovation.

Few of the foregoing ideas, of course, are original. Industrial research councils and institutes are quite common in Europe. In this country, Dr. J. Herbert Hollomon proposed a civilian industrial technology program several years ago that would have provided some

of the same services. And certain aspects of the plan can be found in the Department of Agriculture Experiment Station and Extension Service programs, the NASA Technology Utilization program, and the Department of Commerce State Technical Services program.

I fully realize that European industrial research councils and institutes have been somewhat ineffective, that Hollomon's plan was defeated by industrial pressure groups, and that many of the ongoing Federal technology transfer programs have problem areas.

However, it seems to me that Federal efforts to transfer technology and to accelerate industrial innovation are doomed unless:

1. There is a more coordinated and concentrated Federal program.
2. The problem is attacked on an industry basis rather than a centralized or geographical basis.
3. Some way is found to make companies and individuals take a greater interest in using the benefits of the program.
4. A mechanism is developed to assist industry with common research and associated problems beyond technology transfer.

I am not certain that the system I am proposing will succeed. And I have no idea what it would cost even if it were workable. But it is possible that industrywide technology transfer and research centers could be the missing link in our Nation's extensive research and development network.

Thank you again for the opportunity to present my views to your subcommittee.

Senator RANDOLPH. Thank you, Mr Danilov.

I had thought that perhaps I would question each panelist at the conclusion of his formal statement. I did interrupt you, Mr. Danilov, in one or two places. But I believe now that it would help us if we did this for all panelists at the conclusion of their presentations.

Thank you very much for your excellent statement.

Dr. Kimball, would you speak at this time?

STATEMENT OF DR. CHARLES N. KIMBALL, PRESIDENT, MIDWEST RESEARCH INSTITUTE, KANSAS CITY, MO.

Dr. KIMBALL. Senator, to identify myself, my name is Charles Kimball. I am the president of Midwest Research Institute in Kansas City, Mo.

I do not have a prepared statement. I am going to extrapolate from some remarks which I prepared on a special assignment for the Committee on Science and Public Policy of the National Academy of Science, which group, an ad hoc committee chairmaned by Harvey Brooks of Harvard, included such persons as Edward Teller, Alvin Weinberg, and the like. I was assigned the responsibility of preparing the paper on technology transfer to be included in a report to the Congress entitled "Applied Science and Technological Progress."

We spent a lot of time on these entire issues. And I do want to give you a distillation of my thoughts.

First, I do not think it is an overstatement to express the conviction that this issue of technology transfer may well be one of the greatest intellectual challenges of our time. The institute I head has been involved in this activity in a formal way since 1961. We were the

original NASA contractor in technology utilization. And, of course, prior to that for nearly 25 years we have been facing the issue of transferring the technology that we have developed, to the clients that pay for it.

Those of us who have been working in this field of technology transfer have come actually to understand the extremely complex nature of this problem, and that its successful application, and above all its acceleration, depend on a number of factors.

These range from the type of person involved in the process—which, to me, is the primary issue—to the definition of the purpose of the transfer and its increasing economic relevance.

The process of recognizing a technical advance in one field and establishing its significance in another field has led me to the observation that no single transfer technique is suitable for such a variety and quantity of technology as we are talking about.

And at the beginning I want to define "new technology" as that which is new to the person who needs it, or will use it, and not necessarily new to the technical world in general. This is an important point.

I want to draw five interrelated conclusions, Senator Randolph.

The first is that there must be, nationally, a far better climate and more receptivity to innovation and change. There are, for example, appreciable differences in these elements within the regions and within communities and within various industries, and even among individual companies. The technical gap between certain agricultural States and industrial States in this country may well be greater than that existing in the United States as a whole and many major European countries.

Many companies, both large and small, are not adequately receptive to employing new technology generated outside their own walls. Exceptions are found principally among larger companies, which often have specially designed internal apparatus to bring this about. And we see it also in smaller companies, especially those which have highly knowledgeable, technically trained management.

We find that many companies do not wish to make obsolete either their existing products or their equipment, recognizing as they do the marketing and investment risk that is implicit in new product development. And, perhaps it is for this reason that most transfers have been improvements on existing processes.

The second general conclusion is that the technology transfer process must be problem or need oriented. Overt transfers, for example, could be directed at one or more specific socioeconomic public needs rather than toward private needs, including air and water pollution, waste management, improved transportation, improved education and training methods. And these in themselves, over and above the impact on the private sector, would gainfully employ technical processes developed with Federal funds for one purpose and have them applied to another.

One example of a special target mission oriented effort involves the biomedical applications of aerospace technology, on which we have been expending considerable effort at Kansas City. Its relative success illustrates the value of identifying a group of users having

common technical problems, that is, physicians and medical researchers in several medical schools who uncover and describe quite specific problems. And they work with independent institutes and search the supply of federally derived technical information to help find solutions for these problems.

The third conclusion is that the transfer process is not only complex, but that we need much greater efforts to understand it, how a transfer could or could not take place, and how to design future programs to take advantage of this.

In my view, too much emphasis has been placed on the mechanism of transfer and the special institutional arrangements which conceivably could bring about better transfer. More emphasis needs to be placed on two much more important elements. One of these is the makeup of the supply, that is, the material we are attempting to transfer, in terms of its quality, its quantity, and its relevance. We need to know more about how the supply source works and how its content can be modified and distilled to make it more meaningful.

And the second thing we need to know more about is what causes an ultimate consumer of transfer technology to see and then accept and employ that technology. And both of these elements will give the potential recipient much more confidence in the course, which is presently not adequate.

The fourth conclusion has been discussed, I suspect, in other sectors, and perhaps in this room. And that is that there are a large number of transfer barriers. There are also three sub-barriers.

One is the age-old resistance to change. The second is inadequate skills and narrow viewpoints of people who should be involved in the transfer process. And the third is poor producer-user relationships. And I want to speak about the latter, because it has a direct connection with a former process in our system of higher education.

In fact, I would go so far as to say that the entire process of technology transfer should be dealt with in terms of people.

The problem of information retrieval and the transfer of documents is not the main issue at all. And it has been looked upon as the main issue in many quarters. Hundreds of technical reports sent to a person or an organization, neither capable of handling them nor interested in their interpretation and reduction to commercial purposes, is useless. Some hope has been expressed in the past that scientists and engineers working on Government-financed R. & D. programs could be induced to be more concerned with the possible implications of their work to industry or to other problems of a public nature. This has not been a fruitful source of transfer, largely because the type of person whose aspiration is to achieve scientific and technical progress for himself is generally not the type who also seeks to perfect technology transfer.

Technical and management people in the private sector whose sole association has been with Federal R. & D. programs seldom possess the necessary attributes, insights, or viewpoints to develop products or processes for a highly competitive commercial market.

The technology transfer process is social and economic in form and purpose, rather than scientific or technical. The decisions to use technology, particularly in industry, are economic decisions, rather than

technical decisions. And, therefore, people who are concerned with transfer as their main profession need to be judged on a scale of accomplishment that is quite different from that employed to evaluate and reward convention R. & D. persons.

In order to stimulate, accelerate, and promote this transfer process through overt programs, circumstances must be provided to make it easier for individuals and companies to be innovators. We need demonstrations that markets exist for new technology products, that the risk is reasonable, that the cost-benefit ratio is favorable, and that the competition in a given sector is not excessive. The more of this that is done by the transfer agent, the easier it will be for the ultimate user to become an innovator in his own right.

The type of person I am describing here might be called an "applier of technology." He will have two outstanding personal characteristics, irrespective of where he works.

First, he will understand the world in which commercial forces operate. And he will have some broad technical background. In fact, it might be more advisable and practical to select appropriate generalists, and supply them with the necessary technical facts, than it would be to attempt to convert a conventional scientist through exposure to commercial reality or to the requirements of corporate management.

Experience has shown us that most research scientists and engineers make rather poor transfer agents. Bringing about transfer is not the way they achieve satisfaction. Their education, experience, and general thought patterns do not equip them at all to deal effectively with the major factors that control transfer.

To many persons who generate new knowledge, its transfer to the commercial world, or to more practical purposes, is often considered a secondary assignment, or even a tertiary assignment, only to be concerned with incidentally, or even under duress. New technical ideas are transferred and implemented by persons, not by reports or institutions. And for persons to do this effectively they must operate in an environment that is conducive to new enterprise generation.

The fifth and last conclusion is that the time has come, in my opinion, to consider carefully the deliberate development of techniques, curricular, experiments, or perhaps even new institutional forms to provide this country with many more effective persons who can serve as appliers of technology. The technical entrepreneur, the champion of a new idea, is frequently the main source behind technical change. This person's main strength may be enthusiasm and ingenuity directed toward a commercial or public purpose, and not a basic research point of view. In fact, this person may be more distinguished for these attributes than he is for his technical expertise. His role is a vital constituent of what we are talking about here today. Such individuals need to be described, characterized, and identified as early as possible in their professional lives, to provide them with significant relevant opportunities, and to provide working environments that will make their contributions meaningful.

There are several areas in which this could be brought off—independent research institutes, technical consulting firms, and especially in selective corporate industrial laboratories which have themselves already demonstrated multidisciplinary transfer capabilities.

Technology transfer of any significance will only occur when the right people, the right markets, and the right ideas coincide with usable technology at the right point in time. The technological content, per se, may be the least important element in the transfer process.

Those of us in middle age have to do with the crop of people that is presently available. I think, for example, that certain schools might provide the proven entrepreneur, who is 5 or 10 years out of his undergraduate or graduate work, with some methods of updating himself in the field, so that he will have something to entrepreneur with. A few graduate business schools have started to do this in a commendable way. Special summer institutes including selected graduate students having these entrepreneural skills would be helpful, especially if the faculty were experienced industrial people.

We must also increase the number and quality of these "appliers of technology." And this would be helpful in bringing about more fruitful rapport between university and industry, which leaves a lot to be said about it. Because this is now limited, in my view, by the willingness of many university persons to relate their research or careers to economic or industrial uses.

The training of transfer agents of the type I have been describing here, by exposure to people who know this business could conceivably produce a few score per year of such agents as a minimum. And these people could spin off, then, to companies seeking to bring about transfer in their own interest, or to Government training programs.

That is about all I have to say at the moment, sir.

Senator RANDOLPH. Thank you very much, Dr. Kimball. I compliment you at this juncture because of the very definitive manner in which you are presenting helpful information and suggestions to the subcommittee.

Mr. Hobson, would you identify yourself, sir, and proceed?

STATEMENT OF JESSE E. HOBSON, ATTORNEY AT LAW, HEALD, HOBSON & ASSOCIATES, NEW YORK, N.Y.

Mr. HOBSON. Senator Randolph, I am Jesse Hobson, a partner in the firm of Heald, Hobson & Associates of New York City. My partner is Henry T. Heald, who was formerly president of the Ford Foundation. We do consultant work for universities, colleges, foundations, and nonprofit organizations.

At one time I was head of the Armour Research Foundation, now Illinois Tech's Research Institute, and later I was the head of Stanford Research Institute.

I submitted to you about 20 copies of my statement. I do not intend to read all of it, but I would like to summarize it, if I may.

It has been pointed out before, and effectively, that technology follows need. Usually the requirement is to adapt technology rather than to adopt technology, because usually the problem has to be identified and defined, and then the technology sought to meet that problem or opportunity.

This adaptation process requires a lot of skill, a lot of experience, and a lot of knowledge, both of the commercial situation and of the technology which is available.

Most companies and businesses need assistance in the identification of their problems, and even in the identification of their needs and of the opportunities which exist for those companies to use technology. Certainly it is not usually sufficient just to collect technology and information about it and publish and distribute such information.

The needs and the opportunities for the use of technology have to be discovered, and they must be explored by technicians who are skilled in the adaptation of technology to meet specific needs.

In my opinion only the largest and most experienced companies usually have the skill to define their problems and to find the opportunities for the adaptation of technology. Even some of the largest and the most experienced companies, the companies which are most scientifically and technically oriented, borrow technology from outside their own organizations. In the statement I have submitted to you I cite just one example of interest. In the September issue of Fortune magazine, reference was made to the Nippon Electric Co. of Japan—which, incidentally, is one of the 200 largest companies in the world outside the United States. It is a company which has a sales volume of about $350 million a year, a company that is growing very rapidly, at the rate of 23 percent each year, and a company which spends 5 percent of its sales volume on research—but Fortune magazine pointed out that the company also spends 2 percent of its sales on royalties to use technology which has been developed elsewhere in the world, most of it, incidentally, in the United States.

So I think that we can infer that 40 percent of the technology which is used by the Nippon Electric Co. is imported, and it is adapted.

I think that we need to have a real effort on a national scale to help the small and the medium-sized companies identify their problems and their needs and their opportunities, and to show them where existing technology can be used or adapted to meet their needs.

Some assistance must be provided for them to know when to call on existing sources of technological information, and what to look for, and how to ask for the information, and then how to use the information when it is made available.

They have to have assistance in the adaptation of technology.

In my opinion the universities are not usually the best sources for this kind of assistance. The business of the university is to generate or create, transmit, and store knowledge. The business of the university is not primarily to search out problems and fit possible solutions to those problems. In my opinion both the professors and the graduate students of the universities have other, more pressing interests, frequently quite narrow, vertically oriented interests, and they frequently do not have the broad interests and experience which includes the commercial aspects of the marketplace, the mechanism of the production process, as well as a familiarity or contact with the wide scope of technology which is available.

I would like to remind you that in the field of agriculture it was necessary for us to invent and to develop a new device, the agricultural extension service, to link the research laboratory of the agricultural experiment station and the library of the agricultural school and experiment station with the producers and the processors of agricultural materials.

I believe that the organization that we have available in this country which is best suited to bridge this gap between the existing technology and the need for its adaptation to the marketplace is the research institute, either a nonprofit or profit organization. As a matter of fact, that has been the business of research institutes since the founding of the Mellon Institute in this country about 1911.

In the early days, the early history of research institutes, they were usually involved in the transfer and adaptation of technology from one industry or from one company to another, although I think that frequently they didn't realize that that was exactly what they were doing. Of course, they didn't violate proprietary interests or confidential interests of any company, or violate any patent rights. But they did take known technology developed in one situation or adopted to it and applied that technology in another situation. The staff members of those organizations became quite skilled in the identification and definition of problems and opportunities in business and industry. And they became quite familiar with the dollars and cents requirements of the marketplace.

They became very skilled in adapting technology to fit the needs of a particular company or a particular situation.

The staff members of research institutes became combination scientists, technologists, economists and business managers—or, what usually happened, teams of people were put together experienced and skilled in science, technology, economics, and business management.

After World War II the research institutes sharpened their skills for this process through the addition of economists and business managers and marketing specialists to their staffs. I believe the Stanford Research Institute pioneered the development of—what they called at that time—techno-economics research.

It is true, too, that the research institutes transferred technology from Government-funded projects to private business. I mentioned in the statement that I have submitted to you two examples. The Antenna Research Laboratory at Stanford Research Institute was funded entirely by the Federal Government. The equipment was funded by the Federal Government, and the initial contracts were all with the Federal Government. After a short time the Antenna Research Laboratory sought and got contracts from private industry. A few years later more than half the volume of research activity was supported by private industry. What was going on was a transfer of know-how and knowledge acquired on Government-sponsored projects into private industry.

Another example, also from Stanford Research Institute. The Bank of America financed the application of computers to the banking industry. I believe that is the largest private contract Stanford Research Institute has ever had. If I remember correctly, it amounted to about $7,500,000. I think it is interesting that an organization as traditionally conservative as a bank would spend $7½ million on a venture that certainly involved a great deal of risk. But what happened was the transfer of known technology about computers and computer sciences into the development of a process and a device for application in business.

To return to a previous point, I feel that universities do not have the time, the resources, nor the interest to perform this kind of service most efficiently. It is a diversion of their resources and their objectives to ask them to perform this kind of service. I believe this is one of the limitations of the State Technical Services program in that it has been largely concentrated in universities.

There is one exception that I know about. That is in the State of Mississippi, where the State Technical Services program is carried out by the Mississippi Research and Development Center, which has acquired a skilled and experienced staff of people who will devote their efforts entirely to contacts with industry.

I would guess that the program at Mississippi will be more successful than many of the State Technical Services program efforts in other States where responsibility has been given to universities.

I do believe that there needs to be another link in this chain which connects the laboratory and the development center where technology is generated under Government funding, and the contractors, the information center and the regional dissemination center, connecting to the private commercial user. I believe that the research institutes of this country, with their experienced and industrially oriented, their market-conscious and their management-minded staffs, can perhaps best provide that link on a regional basis.

We should remember that one of the unique resources that we have in this country is the nonprofit research institute. We pioneered in the development of applied research organizations in this country, and the organizations which have developed in other countries have been patterned after ours. We have a number of them now, some 20 nonprofit organizations operating in the country in various regions. We also have a number of profitmaking organizations. We could develop suitable contractual arrangements with the nonprofit and profitmaking research organizations for them to provide this service or transfer of technology to business and industry. We might get a secondary and a side benefit from this activity in that we would bring the research institutes back into closer touch with private industry. I have been distressed to see that many of these research organizations have been diverted from their service to private industry by the ready availability of large Government contracts and Government funding which was easier for them to get than to market their services in private industry.

Thank you very much, Senator.

Senator RANDOLPH. We are grateful for your statement.

(The prepared statement of Mr. Hobson follows:)

STATEMENT OF JESSE E. HOBSON, ATTORNEY AT LAW, HEALD, HOBSON & ASSOCIATES

Mr. Chairman and Members of the Subcommittee, much has been said and written about the desirability and the need to transfer technology and technological developments from the extensive programs of NASA, AEC and DOD funded by the federal government to private business and industry for commercial application in the civilian economy. Considerable accomplishment to this end can be credited to the NASA program for technology utilization, and very probably the States Technical Services program of the U.S. Department of Commerce is rendering a useful service to private businesses. The report on "Policy Planning for Technology Transfer" of the Subcommittee on Science

and Technology to the Select Committee on Small Business of the United States Senate dated April 6, 1967 summarizes very well the benefits to be expected from effective utilization of technology generated, or to be generated, by the extensive in-house and contract research and development activities of the federal government. I do not need to emphasize those points further here.

Technology *follows* need, and the requirement is more frequently to *adapt* technology to a particular commercial situation than it is to *adopt* known technology directly to fit a problem or an opportunity. Adaptation requires skill, experience and a knowledge of both the technology and the commercial situations of production, costs, markets, finance, labor, etc. Many businesses need skilled assistance in the identification of problems, needs and opportunities where existing or adapted technology can be commercially useful. It is usually not sufficient to collect, publish or distribute technological developments, even where those developments are made directly and clearly available to industry. The needs and opportunities for use must be discovered and explored by skilled technicians and methods for adaptation of the technology to meet the specific needs must be investigated and developed. Only the large research and technically oriented companies, experienced in adaptation of technology, are usually capable of discovering and defining their problems and opportunities for technological adaptation and innovation. The smaller companies frequently must have problems and opportunities for technological improvement pointed out to them, as well as to have known technology and its possible adaptation brought to their attention.

Even the largest, most experienced and most scientifically and technically oriented companies borrow technology from outside their organizations and adapt it to meet their own needs, and the process of finding technological developments of possible use in their organizations is not simple, inexpensive or readily apparent.

For example, the current (October) issue of *Fortune Magazine* refers to the Nippon Electric Company of Japan as an importer of technology even though it is one of the 200 (number 145) largest companies of the world outside of the United States, growing at a rate of 23% per year and spending 5% of its sales on research. *Fortune* reports the company spends 2% of its sales on royalties to use the technology developed elsewhere, largely in the United States. One might infer that 40% of the technology used by Nippon Electric is imported and adapted.

Thus I believe a real effort, on a national scale, is needed to help the small and medium sized company identify problems, needs and opportunities where existing technology can be used directly or can be adapted to meet the need. Companies need to be assisted to find *when* to call on the existing sources of technological information (libraries, publications, information centers, etc.), *what* to look for and to ask for, and *how* to use the information which may be available. Even with such assistance, companies will need to have access to both *documented* technology and *undocumented* technology (know-how).

Universities are not often the best sources for such assistance because that is not their business. Their business is to generate, transmit and store knowledge, not to apply it and not to discover problems and to fit possible solutions to the problems. Both professors and graduate students have other, more pressing and usually rather narrow, vertically-oriented interests, not the broad interests and experience including the market place, the production mechanism, and the scope of technology available. It was necessary in the field of agriculture to invent and develop the agricultural extension service with a group of practical, experienced specialists to bridge the gap between the library and the experiment station on one side and the farm or agricultural processor on the other.

The organization best suited to bridge this gap and further the effective use of known technology is the research institute or public service (non-profit or profit) organization. That has been its business for half a century. In the early days of research institutes, specifically before World War II, the research institutes were frequently involved in the business of transferring and adapting known technology from one industry or one company to another, always, of course, being very careful not to violate patent, proprietary or confidential interests of any company. The engineers and scientists of such organizations became skilled in the identification and definition of problems and opportunities, skilled in the practical dollars-and-cents requirements of competitive markets, skilled in knowing where to find existing and known technology, and skilled in adapting that technology to fit the needs of a particular company. Research

institute staff members became scientists-technologists-economists-business managers or, frequently, teams of such skills were put together to work on a specific situation. After World War II the skills of such organizations were sharpened for the process of technology transfer and utilization through the addition of techno-economists, business managers and marketing specialists to their staffs.

During and after World War II the research institutes also had the opportunity to engage in research and development on government sponsored projects and to apply the know-how thus acquired to the commercial opportunities of private business. As just one of many examples, the antenna research laboratory at Stanford Research Institute was financed and established through government contracts but it later grew and became quite active in projects for private industry. The development of computers for banking purposes including the magnetic numbering and reading of account numbers on checks came largely from work at Stanford Research Institute sponsored by the Bank of America using and adapting known technology in the computer sciences.

Universities have neither the time, resources, nor interest to perform such services most effectively. It is largely a diversion of their resources and objectives to ask them to do so. In my opinion, this will be a serious limitation of the State Technical Services (U.S. Department of Commerce) program. The STS program in Mississippi, to be carried out by the state-supported Mississippi Research and Development Center with an experienced staff devoted exclusively to contacts with industry, will probably be more successful than the STS programs in some other states where responsibility has been given solely to one or more universities.

The NASA program of Technology Utilization, useful as it has been, needs another link in the chain of laboratory, development center, contractor, information center, regional dissemination center and private commercial user. I believe the research institute, with its experienced, industrially-oriented, market-conscious, management-minded staff, can best provide that link on a regional basis. On page 170 of "Policy Planning for Technology Transfer" is printed a statement with which I heartily concur: "The personal contact is noted as the most important transfer mechanism." Again, on page 171, "The more successful transfer programs seem to be characterized by repeated contact between users and suppliers, thus building up a 'trusted source' relationship," and ". . . I question whether the important role such organizations (research institutes) play in technology transfer is sufficiently well understood."

May I direct the attention of this Subcommittee to pages 169–180 of the publication to which I have referred. I do not believe the technology transfer process can best be done in its final phase of contact with the commercial user by a new government agency, a "Comsat-like approach," or by any existing agency or unit of government. I think it can probably best be done through existing research institutes (non-profit and profit) on a regional basis through suitable contractual arrangements. A secondary and side benefit would be to bring the research institutes back into closer touch with private industry, from which many of them have been diverted by the ready availability of large federal government funding for government contracts.

Senator RANDOLPH. And I now call on Dr. Weimer to comment.

STATEMENT OF DR. ARTHUR M. WEIMER, SPECIAL ASSISTANT TO THE PRESIDENT, INDIANA UNIVERSITY; AND VICE CHAIRMAN, AEROSPACE RESEARCH APPLICATIONS CENTER, BLOOMINGTON, IND.

Dr. WEIMER. I am Arthur Weimer. I am special assistant to the president of Indiana University, and vice chairman of the Aerospace Research Applications Center, which is one of the NASA regional dissemination centers. And I am currently spending about a third of my time as executive vice president of the American Association of Collegiate Schools of Business.

Those of us who are associated with the NASA technology utilization program have been interested in economic growth. Some of us

have been concerned primarily with the economic growth of our States and regions, others primarily with the economy as a whole. We have been trying to increase the return on our national investment in the space field by developing additional uses of the knowledge arising from the effort. We have tried to do this in a variety of ways. Our particular activity at Indiana University represents one approach; it has been an interesting experiment in Government-industry-university cooperation and on the whole, we believe, a successful one.

We established, on a cooperative basis with NASA and a number of industrial firms, the Aerospace Research Applications Center in the late fall of 1962, putting the center into operation in the spring of 1963. Starting with 29 companies, 67 are now involved in the work of the center. Of these, about one out of four may be considered smaller companies. The center has also carried forward a variety of efforts with other universities, particularly in the middle western region, and has worked with several research institutes. A list of member companies and other companies and organizations with which we work is provided as an attachment to this statement.[1] The member companies pay annual fees ranging from $150 to over $10,000.

I will not try to outline in detail the work of the center, but would like to submit a statement prepared by Mr. Charles W. Mullis who is associate director for operations of the center.[2] This statement was prepared for the 22d annual conference of the Industrial Society of America and in it Mr. Mullis describes the ways by which the center has undertaken to make available to the industrial community not only the technology arising from the space program, but from various other Federal R. & D. efforts as well, notably those of the Department of Commerce, the Atomic Energy Commission and, to a more limited extent, the Department of Defense. We have found that companies and other organizations like the idea of an information center that can provide access to many types of Federal and other R. & D. information.

In addition, the center draws on the resources of Indiana University as required, and in some instances has drawn on the resources of other universities and research institutes as well. Of special importance for the success of the center have been such resources of Indiana University as the services of Chancellor Herman B Wells, Prof. Howard L. Timms, and the director of the center, Dr. Joseph DiSalvo.

Knowledge is being recognized increasingly as one of our most valuable resources for stimulating economic growth. We undertake major efforts every year to expand our storehouse of knowledge and we believe by using the knowledge developed for one purpose—such as space exploration—in a variety of other ways through industrial application of such knowledge, we can add greatly to the growth potential of our knowledge resources.

To a large extent this is an educational effort, but it is an education effort of a very special kind. It involves work with thousands of documents and publications. We have learned how to search hundreds

[1] See p. 59.
[2] See p. 52.

of thousands of reports by computer after they are indexed and abstracted through the work of NASA and its contractors. We have learned the high-priority interests of the companies with which we work and have made a variety of efforts to adapt this knowledge to their needs. In 1963 some 600 copies of various types of reports were requested by the member companies of the center; in 1966, 30,000 copies of such reports were requested. This gives some indication of the growing interest in this general area.

The type of education effort in which we are engaged requires the careful coordination of the work of many people in government, industry, and the universities. It is not easy to do this, as we have found. Like other educational efforts, technology utilization programs tend to be resisted by the very people who need help the most. These include many small business managers and the managers of larger firms who do not recognize the potential impact of new knowledge on their products and markets.

As in the case of educational programs generally, the results of technology utilization programs are not easy to measure. It is not easy to secure from industries specific information about applications of the knowledge which they have put to their particular uses. We have some recent information of this type, compiled by Mr. Robert W. Hall——

Senator RANDOLPH. Dr. Weimer, at this point I will note that we will include the material that you have mentioned as supplementary to your statement.

Dr. WEIMER. Thank you very much.

I should also like to submit Mr. Hall's report as a supplement to this statement.[3]

Also of special interest along these lines is a report submitted to Mr. Melvin Yelvington of the Small Business Administration by Mr. R. J. Loubier of Prosthetics, Inc. This report indicates the ways in which we were able to assist in the development of an artificial heart project.[4]

Senator RANDOLPH. It will be considered.

Dr. WEIMER. Thank you very much.

People in industry who could provide valuable insights regarding our programs include Dr. Robert T. Watson, president, ITT Industrial Laboratories, Fort Wayne, Ind.; Mr. Maurice R. Eastin, president, Esterline Angus Instrument Co., Inc., Indianapolis, Ind.; Dr. Guido Stempel of General Tire & Rubber Co., Akron, Ohio; and Mr. R. A. Gaiser, vice president, Research and Product Development, Ball Brothers Research Corp., Boulder, Colo.

Not only has the direct transfer of knowledge been useful, but also ideas have been generated by putting people in touch with literature of a type they might not ordinarily encounter in their regular activities. This often leads to some unanticipated developments. We think it particularly the function of universities to stimulate ideas and new lines of thought and we believe that our center has made several contributions to this process. We must recognize, however, that we know very little about the creation and development of ideas.

[3] See p. 58.
[4] Retained in committee files.

Even though we have made some progress, much remains to be done. First, we hope to develop more widespread interest on the part of the academic community in multiplying the uses to which new knowledge can be put. Considerable interest has developed in recent years in courses in the area of R. & D. management; the management of technology utilization may develop as a part of such courses or may be accorded some special attention of its own. Experimental seminars in these areas might well be supported. Recently I have undertaken an assignment as executive vice president of the American Association of Collegiate Schools of Business, devoting about one-third of my time to this work. I have been interested in some of the developments that might be possible in the programs of the business schools along these lines. Engineering schools, undoubtedly, will have a special interest in this area as well. Also, information about the management of technology transfer could well be included in various executive and management development programs.

Second, we need even broader access to Government R. & D. programs and their results. The Department of Defense provides only a limited amount of information, for example. The security problems here are recognized, but possibly more could be done not only with respect to this agency, but with respect to others in the Federal system.

Third, the process of transferring and applying knowledge needs more widespread support. The support provided so far has been relatively limited. Experience with our own center indicates that industry is willing to bear its share, because the aspect of our work which relates directly to industry, and not to our own research and development efforts, will be largely on a self-supporting basis by the end of 1967. Our experience suggests that business firms are willing to pay for the value that is added to Federal knowledge resources by such services as are performed by our center. These include the adaptation of the information to the needs of the business firms, the development of computer research strategies, the effort of members of the center to relate the high priority interests of the firm to the knowledge sources that are available, and to refer inquiries to other sources of knowledge if no information of the type desired can be provided directly by the center.

Sometimes companies contend that they should have Federal R. & D. information free of charge because it is a Federal resource. There is no question about this, and I should point out that we are not charging companies for information, but for information services and for the value added to the basic information by our efforts. It should be remembered that much needs to be done to the basic knowledge resources to make them useful to a business firm. Time and effort must be expanded by the business firm itself, as well as by members of the center, to give these knowledge resources real value in the solution of specific problems.

Fourth, in order to make the programs for technology transfer more effective at the present time, it would be desirable to coordinate to a greater extent the efforts of Government agencies, universities, research institutes, and industrial firms. We need to develop better organizational arrangements for working along these lines and, perhaps,

a regional approach offers some possibilities. Cooperative efforts between various Federal agencies might well be continued and expanded.

NASA has undertaken some work with the Small Business Administration. This might be expanded to advantage. We must recognize that additional efforts in the small business area should be undertaken by ARAC and similar organizations. Perhaps internships for graduate students in business administration and engineering might serve useful purposes in the small business field, especially with respect to technology utilization.

Additional cooperative efforts between NASA and the programs of the Department of Commerce, the Department of Housing and Urban Development, the Department of Defense, the Atomic Energy Commission and others undoubtedly would produce additional returns on the knowledge resources arising from the space program.

We need to learn to work more effectively with various industrial organizations and associations as well. In some cases trade associations and professional societies may be able to do more than has been possible so far, assuming the necessary support can be provided.

Fifth, I have been favorably impressed with the efforts of the engineering foundations to develop more widespread interest in technology transfer and utilization, through a series of conferences that were held at Proctor Academy in Andover, N.H. The National Science Foundation, in cooperation with the National Planning Association, conducted a first-class conference on this subject in the spring of 1966. Last summer we held a National Conference on Technology Utilization and Economic Growth at Indiana University with support from NASA and the Office of State Technical Services, as well as the Indiana University Foundation. At this conference the Honorable J. Edward Roush, Congressman from Indiana's Fifth District, stressed the need for calling additional attention to, and even "glamorizing," as he put it, programs of technology utilization. Efforts of this type should be continued and encouraged since conferencing is one means of stimulating interest in a subject as well as to transfer and utilize the knowledge that is developing about it.

Finally, we need to learn more about the process of technology transfer. In my judgment we have only begun to unlock the potential that exists in this field. I believe that the universities may be able to make substantial contributions in this area. For example, there is now much interest in the academic community in the information sciences. Many of the scientific departments have taken a special interest in the more effective organization of knowledge with retrieval by means of the computer. Graduate libraries are especially concerned with the possibilities in these areas. The business schools also have taken an increasing interest in management information systems and their development. The NASA system has certainly made substantial progress and the experience with this program may provide a valuable body of knowledge for the further development of broader studies in the information sciences.

Thank you very much, Mr. Chairman.

Senator RANDOLPH. Thank you, Dr. Weimer.

(The supplemental information submitted by Dr. Weimer follows:)

Some Techniques for Automatic Searching of Government Report Literature

(By Charles W. Mullis, Associate Director for Operations, Aerospace Research Applications Center, Indiana University, Bloomington, Indiana)

ABSTRACT

A brief description of the NASA Technology Utilization program objectives as they are related to the Regional Dissemination Centers is presented. The techniques and resources employed by the Aerospace Research Applications Center, Indiana University, in processing the government report literature are discussed. Particular attention is devoted to the work accomplished in search of reports containing solutions, or approaches to solutions, of problems submitted by the participating member firms.

Introduction

The lives of 900 men placed end to end would span the last 50,000 years of man's existence, as we understand it, on this planet. The first 650 of those lived in caves and natural habitats, or worse. Only the last 70 had any effective means of communicating with each other. The last six saw the printed word and could measure temperature. Only the last four could measure time with meaningful precision. The last two have been privileged to benefit from the electric motor. Almost everything which makes up the man-made portion of our environment has come about in the life span of the 900th person.

There are those who would claim that technology is already racing ahead at such a breakneck speed that nothing need be done to promote the adoption of new technology. Public policy does not support this view.

NASA Technology Utilization.—The Space Act of 1958 which created the National Aeronautics and Space Administration, contained specific reference to the utilization of the results of the space research program. As Mr. Webb interprets that Act:

> It is our objective, in accordance with the directives given by Congress and the President in creating NASA, to insure that developments resulting from NASA's scientific and technological programs be retrieved and made available to the maximum extent for the nation's industrial benefit in the shortest possible time, through strengthening the bridge between technical research and marketable end use.

To initiate action toward this objective, NASA implemented the Office of Technology Utilization (OTU). One major dimension of the Technology Utilization program is the Regional Dissemination Centers (RDC's) located at universities and non-profit institutions. In addition to providing funds to support research into the methods of achieving the basic mission, the OTU furnishes the RDC's certain resources with which to work.

These will be discussed later.

The Aerospace Research Applications Center (ARAC), the first university RDC, was established at Indiana University in 1962.

ARAC Mission.—At its inception, ARAC was given the mission:

> To disseminate to civilian-oriented industry the results of the nation's governmental research and development programs for the purpose of:
>
> Aiding in the development of new and improved products, processes and materials for commercial markets;
>
> Precluding duplication in industrial research and development programs of work already done in whole or in part by government programs.

Activity got underway in 1963 with twenty-nine charter member companies, each paying up to $5,000/year to participate in what was defined as a research experiment in the management of technical information as a business resource. Membership has now grown to over sixty participating firms. This growing membership has reduced the need for NASA to support the operating services which have been established; and permitted NASA to concentrate on the basic problems in the areas which are yet to be researched.

Figures are often deceiving, but a feel for the growth in effectiveness of the program at ARAC can be obtained by comparing the number of reports supplied during the first year of operation and the number supplied during the year just past. In 1963, of all the reports identified in response to problems submitted by

our member companies, 599 copies of reports were requested. In 1966, 30,948 copies of reports were requested.

Resources.—Early in the game, NASA saw the need for an effective vehicle to keep the scientists and engineers engaged in research directed toward the space mission appraised of the latest developments in their respective fields. To this end they established two literature indexing activities, one with the Institute of Aeronautics and Astronautics and one with Documentation Incorporated. The Institute of Aeronautics and Astronautics reviews some 850 to 1000 open literature journals, both domestic and foreign. From these they select the reports that relate to the various research activities of NASA, and prepare abstracts and keyword indexes of the reports. Usually 15 to 20 keywords are selected for each report. An abstract index journal, called the *International Aerospace Abstracts* (IAA), is then published semi-monthly.

Documentation Incorporated performs a similar task, gleaning aerospace-related reports from the U.S. Government report literature—both in house and contract—and from all branches of the government—Department of Defense, Public Health Service, NASA, AEC, etc. In addition to publishing the abstract journal *Scientific and Technical Aerospace Reports* (STAR), Documentation Incorporated prepares a computer tape for each combined issue of STAR/IAA which contains all the pertinent citation and index information. It is this tape which, next to our people, is our single most important resource. Of course, this presumes a computer that fits the tape and at Indiana University we use a CDC 3600 with a CDC 3400 satellite system.

Other material resources provided by NASA include the journals themselves, multilith mats of the abstracts, sets of abstracts in microfiche and card format and full copy of the reports—both in hard copy and microfiche format.

Our greatest resource is our people. We currently have 12 engineers and scientists who work 24 hours per week. All have a minimum of a bachelor's degree in their chosen discipline and some have master's degrees. All have industrial experience; some as much as six and eight years. In addition to working for ARAC they are pursuing advanced degrees at the University in such areas as Law, Business Administration, Mathematics and Economics. We believe that the rare combination of talents possessed by the members of the staff has been the key to the successes that have been achieved to date. It is, perhaps, unnecessary to point out that such a combination of people talents would be difficult to assemble anywhere except in an academic environment.

Finally, we need problems against which to direct the efforts of the staff. Our member companies provide these in many forms.

So much for the resources. Now let get into the specifics of the actual operations.

Operations

Weighted Term Strategies.—For those of you who are not familiar with the use of computers to perform boolean algebra type sort and match routines, the procedure is basically as follows:

1. Ask the computer for all items (reports) identified (indexed) under a particular label (keyword) or combination of labels (keywords). Combinations are arranged by linking keywords with "and, or, not" logic statements.
2. The computer searches the file and prints out the accession numbers (report numbers) of the reports identified.

For instance, the question submitted might be:

high altitude + bearing

On December 22, 1966, the complete STAR/IAA file contained 790 reports indexed under "high altitude" and 1092 reports indexed under "bearing," but there were only seven reports indexed under both. Hence, the computer would print out the accession numbers of the seven reports common to both terms.

One of the first major research efforts of ARAC was the doctoral dissertation of Dr. Ralph H. Sprague, Jr. Sprague compared and evaluated four different search logics: (1) boolean request logic, (2) number of profile terms occurring in the document index, (3) percentage of document index terms appearing in the profile, (4) weighted term profile. Based on Sprague's work, ARAC adopted the weighed term strategy.

The basic concept with the weighted term strategy is that an engineer or scientist familiar with both the technological discipline and the indexing system can weight each term in the profile in terms of its relative importance to the interest area being served. Our system permits weighs between +9 and −9. The computer then selects all terms from the document index which appear in the profile, adds their weights and assigns this aggregate weight to the document. Then the accession numbers for all documents whose weights exceed the cutoff weight assigned by the engineer are printed out by the computer.

This strategy enables us to easily build much more tonal quality into the profile than is possible with the boolean approach. For example, let us return to the high altitude + bearing search. When I cited it before perhaps you thought of gyroscope bearings for aircraft and space guidance systems. Let's take a look at one of the seven reports accessed:

N66–31414—"Certain Data From Research on the Sexual Activity of Women Residents Under the Conditions of the High Mountains."

Those of you who are students of the redundancy in the English language will guess immediately that this humorous bit of cross-talk comes from "bearing," meaning "child bearing." To eliminate this from a gyroscope bearings search, for instance, using the weighted term strategy is very easy:

Cut-off weight	=9
Gyroscope	=5
High Altitude	=4
Bearing	=4

This little three term search would pull under high altitude + gyroscope and gyroscope + bearing, but not high altitude + bearing. When one considers the possibilities of interest profiles consisting of 80 to 100 terms, each weighted between −9 and +9, you can begin to get a feel for the power of the system.

Of course, it still can't compensate for the engineer who can't spell. Recently, we were doing a search on grinding fillet radii for crankshaft journals. The engineer misspelled "fillet" when he wrote the search profile and as a result he accessed a number of reports on fileting fish.

With this background on how the computer is used, we can now discuss the mechanics of how we interact with the member companies.

Selective Dissemination Service.—The SDS operational system is schematically diagrammed in figure 1. At first glance it looks like a complicated network of feedback loops, but it is really very simple. Briefly, the steps are as follows:

(1) The company user writes out a narrative description of his work interest areas answering such questions as: What specific technology is involved? Is the main thrust in research, design, manufacturing, service, theoretical analysis, or practical techniques and application, etc.?

(2–3) Using the thesaurus of index terms currently being employed by Documentation Incorporated and IAA, the ARAC engineer prepares a weighted term profile. Usually, it is desirable to discuss the interest profile with the user by telephone during the process of writing the weighted term profile.

(4–5–6) The profile is then keypunched, fed into the computer and the list of accession numbers returned to a reproduction shop which prepares a copy of the abstracts for each accession number and the abstracts are then sent to the engineer.

(7–8) The engineer reviews the abstracts and culls out all the "fish filets." Also, there are a number of criteria the engineer can apply directly that it is not possible to build into the weighted term profile. The remaining deck of relevant abstracts is mailed to the user.

(9–10–11–12) To improve the quality of the profile, the engineer can submit the list of relevant and non-relevant document numbers for a profile analysis. The computer will give him a listing of all the index terms for all relevant documents and all the index terms for all non-relevant documents and how many documents accessed by the profile, relevant and non-relevant, are indexed under each term.

(13–14) Concurrent with the 9 through 12 loop, the user is reviewing his output. The feedback he provides relative to which abstracts seem to describe relevant reports and which are non-relevant enables the engineer to adjust his understanding of the interest and revise the profile (the 15–16 loop) accordingly.

(15–16) The engineer can then revise the profile—changing weights and adding or deleting terms so that the profile more closely reflects his impression of the interest being served.

(17–18) Of course, abstracts can be misleading and the best user feedback comes from which documents the user felt were sufficiently promising to warrant ordering the full copy of the report.

(19–20) Finally, as the user solves problems and addresses himself to new areas of interest he can advise the ARAC engineer accordingly and the 15–16 loop can again be exercised.

Profiles "settle down" very rapidly. After three or four semi-monthly issues have been processed and the feedback loops have been exercised perhaps twice each, the profile will run for several months before subtle shifts in indexing techniques or changes in the emphasis of research being reported may suggest revision. Currently, about 10% are revised each issue. These revisions range from as simple as changing the weight on a term to as extensive as a major overhaul to include new interests not previously covered.

Retrospective Search Service.—Although the use of the computer in performing an RSS is essentially the same as in performing the SDS, there are unique differences. An RSS is a one time only occurrence. There is no opportunity to exercise any of the feedback loops to refine the search strategy as is the case with SDS. An RSS is run against the entire file of about 300,000 reports rather than the 3,000 or so in each issue of STAR/IAA. Hence, it must be much more specific and to the point. Also, since this service is directed toward finding solutions to specific problems, it is at times appropriate to exercise many other information channels when the search of STAR/IAA does not identify pertinent reports.

The RSS system diagrammed in figure 2 operates as follows:

1. The user communicates his problem to ARAC via mail or telephone and the RSS coordinator assigns it to the ARAC engineeer whose professional background most closely matches the area of the problem. The ARAC engineer then contacts the user to discuss the problem and insure that he has complete understanding of what is sought.

2. The ARAC engineer then writes a weighted term strategy and obtains a print out of the STAR/IAA file from the computer. The edited results (deck of abstracts of relevant reports) of this machine search are mailed to the user within two weeks of receipt of the problem.

3. In the event appropriate reports are not identified in the NASA system, the ARAC engineer performs manual searches of *United States Government Research & Development Reports, Nuclear Science Abstracts, Engineering Index, Applied Science and Technology Index,* or any other journal we have available that he feels may identify reports relevant to the problem solution.

4. If he is still unsuccessful he may elect to contact some of the specialized information centers. There are many of these in existence. Some which we have frequently used include:

A. Plastic Technical Evaluation Center
B. Defense Metals Information Center
C. Air Force Machinability Data Center
D. Ceramics and Graphic Information Center
E. Science Information Exchange
F. National Referral Center, Library of Congress.

5. When relevant reports are found—either by machine search or manual search—copies of abstracts of the reports are sent to the user along with a transmittal letter identifying the sources of the abstracts and the ARAC engineer's evaluation of their relation to the problem being worked on. When the solution has been found or all sources have been exhausted, the search is terminated.

Of course, full copy of the NASA reports is available from ARAC as a final output. Where the report is not available from ARAC, the user is appraised of potential sources from which the reports may be obtained.

Other Activities.—Other services performed by ARAC include the Industrial Applications Service (IAS), Computer Information Service (CIS), and Marketing Information Service (MIS). A Management Science Service is currently under development.

The IAS is directed toward identifying reports which have a high potential of industrial application. In their daily intercourse with the report literature, the

ARAC engineers and scientists are continually finding reports describing techniques, processes, or "gadgets," that they feel some industry or firm could advantageously exploit. Eight such reports are announced each week along with copies of NASA Tech Briefs. It is to be emphasized that this is not a customized service aimed at a specific problem or interest area. The two criteria used are industrial applicability and completeness of the report.

Sometimes, however, the IAS has been the initiator of a chain reaction involving the customized services. On Industrial Appliance Report may generate an idea which leads the user to questions relative to the technology involved. An RSS (or several depending on the questions) is initiated to determine the current state of the technology. The company may then decide to initiate a research or development project to marry itself to the technology. During the course of the project they may want it served with an SDS profile to keep them abreast of what other developments are emerging in the area.

The Computer Information Service was originated by ARAC in conjunction with the Marshall Space Flight Center, Huntsville, Alabama. The purpose was to determine the industrial utility of computer programs developed for NASA under government contract. Complete program tapes or card decks and documentation were made available to ARAC member companies.

The initial response was quite positive and NASA has since established at the University of Georgia a center called Computer Software Management Information Center (COSMIC) with the mission of making these programs available on a national scale. ARAC announces monthly to the member companies any new programs available from COSMIC and augments this with an SDS output in the general area of computer techniques. Obviously, the CIS can be the initiator of a chain reaction involving the customized service in much the same way as does the IAS.

The MIS includes a monthly abstract service and a retrospective search service which is simply a regular performed with a marketing objective in mind. "New Dimensions in Marketing Technology" is a monthly mailing of approximately ten abstracts of articles. These articles are selected to provide marketing managers with information on new developments in other areas—Operations Research, Communication, Sociology, etc.—which are making significant contributions to marketing management.

The specific aim of "New Dimensions" is to acquaint subscribers to this service with new techniques and methods. To this end, the ARAC staff scans approximately 60 journals in an effort to pinpoint articles which would be of interest to marketing personnel. Typical of the journals which are regularly searched are the *Journal of Marketing, Journal of Marketing Research, Journals of Advertising Research, Harvard Business Review, Business Horizons, Management Science, Journal of Operations Research, American Journal of Sociology, International Science and Technology,* and various law journals.

The marketing retrospective searches are designed to encourage marketing people in each member company to utilize the technical information capabilities of ARAC in solving marketing problems. The initial output from ARAC in this service is a set of abstracts as in the Retrospective Search Service.

Marketing questions are treated as searches in the Retrospective Search Service. Requests for specific information will be answered by a manual or computer search of the scientific and technical information sources available to ARAC. These questions may be for market facts and data, the identification of market opportunities for existing technology and products, the identification of firms active in specific technical and product areas, market projections, and various other questions.

In an effort to provide a more economical Selective Dissemination Service, ARAC developed Standard Interest Profiles where we take the initiative of defining a particular subject or area of interest. The user can then quickly determine the extent of his interests in the area.

The Standard Interest Profiles which are incorporated in the Management Science Service provide a unique opportunity for participants to benefit from the availability of information on complex management problems and programs found within the government areas. Many of the current tools and techniques of management planning and control, such as Operations Research, PERT, CPM, and Systems Analysis have been developed in connection with various govern-

ment activities. Profiles currently included in this service are: Production Control and Manufacturing Engineering, Quality Control and Reliability, Information Systems, Personnel Management and Behavioral Sciences, Research and Engineering Administration, Operations Research, Economic Planning and Cost Analysis, Logistics and Distribution Analysis, and Computer Technology.

Conclusions

The fifth year of the ARAC experiment is rapidly drawing to a close. Experience gained in the developments discussed above lead one to a number of observations worth noting. It is to be emphasized, however, that these observations are not founded on cold, hard data resulting from specifically designed research as such—they are reflections of experience.

It is possible to use automatic techniques for searching government report literature and do it at a cost that industry is willing to pay, provided the operation does not have to underwrite the cost of preparing the literature base for search purposes.

There is a serious need to educate the engineer or scientist in the industrial climate in the use of such systems as have been discussed above.

A wide variety of services is required to adequately serve the needs of the many types of technical people in the industrial climate.

Acknowledgement

The work of the Aerospace Research Applications Center is partially supported by the National Aeronautics and Space Administration Office of Technology Utilization. Current Contract numbers are NASr-162 and 15 003 032.

References

(1) NASA's Technology Utilization Program, U.S. Government Printing Office, 1965.

(2) R. H. Sprague, Jr., "A Comparison of Systems for Selectively Disseminating Information," *Bureau of Business Research*, Indiana University, Bloomington, Indiana, 1965.

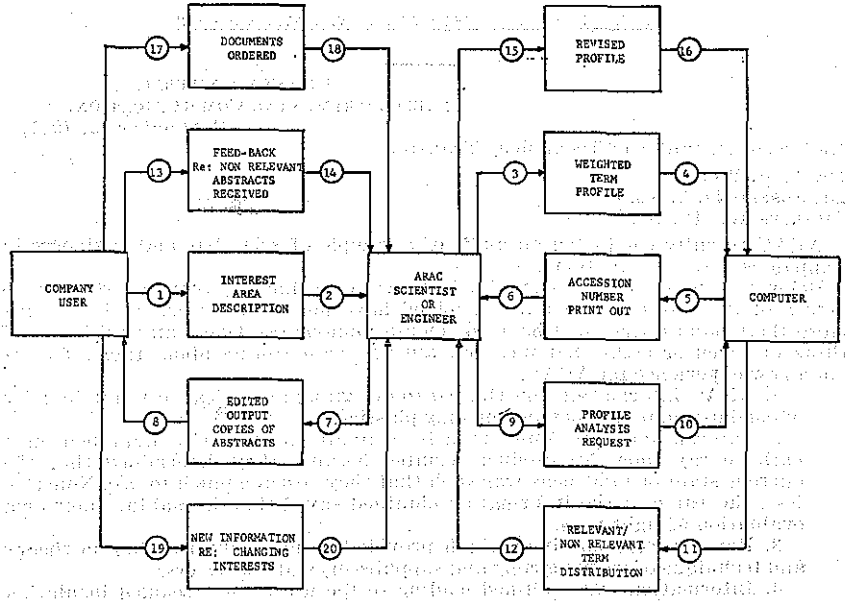


FIGURE 1 SELECTIVE DISSEMINATION SERVICE SYSTEM DIAGRAM

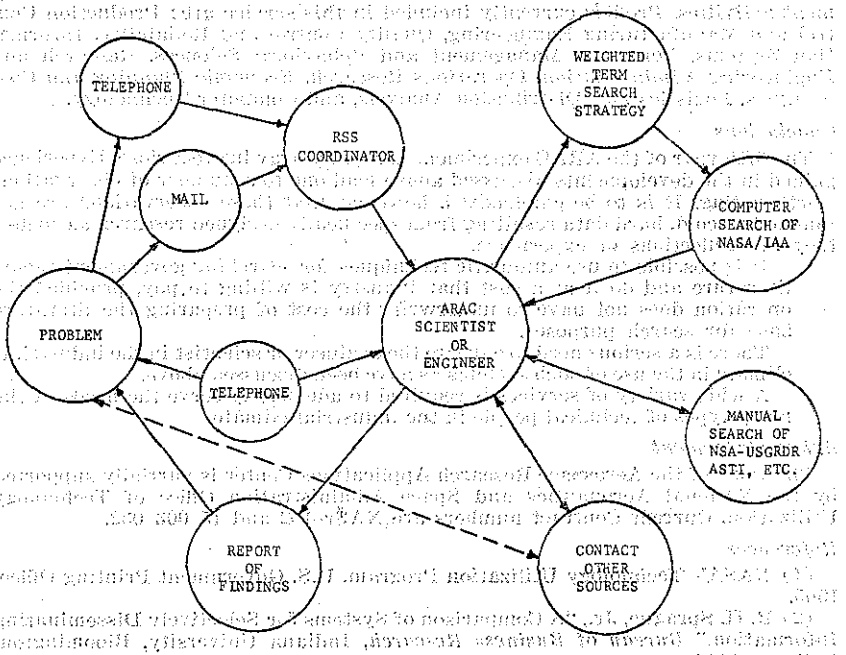


FIGURE 2 RETROSPECTIVE SEARCH SERVICE SYSTEM DIAGRAM

INDIANA UNIVERSITY,
INTERDEPARTMENTAL COMMUNICATION,
September 22, 1967.

Re Recent Instances of Technology Transfer

Dr. A. M. WEIMER,
Dr. JOSEPH DISALVO,
CHARLES W. MULLIS.

ARAC recently conducted an audit of a sample of scientists and engineers in companies using ARAC services.

Below is a summary of the specific instances of technology transfer which were obtained. Because the companies involved have not given us permission to disclose their names, they will have to remain anonymous. One man said he could think of seven or eight examples, but did not want to talk about them. This is not a new experience for ARAC.

1. ARAC information contributed to designing analytical tests for toxicity of combustion products from burning plastics.

2. Information was found to help evaluate the use of a light pen on a cathode ray tube. No product resulted because they determined that the current state of light pens was such that they cost too much to use. Nonetheless, the value of the information obtained saved time in making their own evaluation of light pens.

3. Reports were obtained which provided valuable information on theory and technique of growing ruby and sapphire crystals for lasers.

4. Information was obtained leading to the use of new foamed insulation for cryogenic application. These were used both on cryogenic storage tanks and on cryogenic transfer lines.

5. Reports obtained were used in the design of a liquid helium bubble chamber.

6. ARAC references were used to obtain information on heat transfer through vacuum. Two dimensional heat radiation in a vacuum was the problem of specific interest.

7. A search of government reports done by ARAC was useful in designing a program for selection and training of employees to repair electronic equipment.

8. A special document from ARAC provided government test data on a new experimental product (the interviewee refused to discuss it further, and it was felt that a competitor's product was what he was referring to).

9. An abstract of a report which was obtained from ARAC, was responsible for introducing the company to a thin film transducer particularly useful for ultrasonic detection.

10. One individual mentioned that a survey on crystal nucleation had been of value to the company. He did not comment more specifically.

11. Another interviewee mentioned that his firm uses consultants a great deal. They sometimes use ARAC searches of government reports to find out who is active in a field of interest. This partially serves as a search process for a consultant.

12. A report from ARAC was instrumental in a solution of a filtration problem. The product on which the problem occurred is believed to be a new one, but the interviewee did not comment further.

ROBERT W. HALL.

ARAC MEMBER COMPANIES

Abbott Laboratories
Air Preheater Company, Inc.
Allison—Division of GMC
Andrew Corporation
Arvin Industries, Inc.
Ashland Oil Refining Company
Ball Brothers Research Corp.
Borg-Warner Corporation
Brookside Corporation
The Carborundum Company
Cincinnati Milling Machine Co.
Cities Service Company, Inc.
Coats & Clark Incorporated
Cummins Engine Company, Inc.
The Dalton Foundaries, Inc.
Delco Radio Division—GMC
Delco-Remy—Division of GMC
Diamond Alkali Company
Eli Lilly and Company
Esterline Angus Instrument Co.
Franklin Electric Company, Inc.
GE-Motor and Generator Div.
The General Tire & Rubber Co.
The B. F. Goodrich Company
Harris Intertype Corporation
The Harshaw Chemical Corp.
Div. of Kewanee Oil Co.
Hoffman Specialty Mfg. Corp.
Howard W. Sams & Co., Inc.
Indiana Bell Telephone, Co., Inc.
Ind. Instrument & Chem. Corp.
International Harvester Co.
ITT Federal Laboratories
ITT Industrial Laboratories
Jenn-Air Corporation
Kerr-McGee Oil Industries, Inc.
Kimberly-Clark Corporation
Kurfees Paint Company
Link-Belt Company
Mead Johnson & Company
Mid-Continent Carton Corp.
Mobile Oil Corporation
New Castle Products, Inc.
Nuclear-Chicago Corporation
Owens-Illinois, Inc.
Penn Controls, Inc.
Pollak and Skan, Inc.
Potter & Brumfield, Div. of American Machine & Foundry
Public Service Indiana
Pullman Incorporated
Radio Corporation of America
The Roberts Brass Mfg. Co.
Robinson-Houchin, Inc.
Sarkes Tarzian, Inc.
Sinclair Research, Inc.
Skelly Oil Company
Steel Industries, Inc.
Streeter-Amet Div., Mangood Corporation
Sun Oil Company
Systems Sciences, Inc.
Texas Gas Trans. Corp.
Texscan Corporation
Union Carbide Corporation
Welco Industries, Inc.
Westinghouse Electric Corp.
Wheel-Horse Products, Inc.
Xerox Corporation

OTHER FIRMS AND ORGANIZATIONS USING ARAC SERVICES

American Asso. of Collegiate Schools of Business
Case Institute of Technology
Center for Application of Science and Tech. Wayne State University
The Coca-Cola Company
Dept. of Housing and Urban Development
The Diebold Group, Inc.
The Georgia Power Company
Georgia Technical Services Office
Goddard Space Flight Center
Illinois Technical Services Office
Indiana University
Jefferson Mills, Inc.
Lewis Research Center
Mass. Institute of Technology
Maxwell Air Force Base
Midwest Research Institute
New England Research Application Center University of Connecticut
North Carolina Science & Technology Research Center
Northwestern University
Ohio State University
Prosthetics, Inc.
Roper Pump Company
Rose Polytechnique Institute
Scientific-Atlanta, Inc.
Small Business Administration
Southern Saw Service, Inc.
Southwire Company
Stanford University
Syracuse University
Technology Applications Center University of New Mexico
Technological Use Studies Center Southern Oklahoma State University
University of Cincinnati
University of Kentucky
University of Maryland
University of Notre Dame
University of Pennsylvania
University of South Carolina
University of Tennessee
University of Texas
The Warren Co., Inc.
Washington University
Western Research Applications Center University of Southern California
Wisconsin University

Senator RANDOLPH. I have noted the theme that has been running through the testimony. I have noted that you called for new efforts, for new training, and for new manpower. You have indicated that all this will be beneficial to the business community.

Now, where did it go? I think it is imperative that the funding of transfer programs come substantially from those who benefit. I am not sure that this is exactly true, but I would like to have your thinking. And if it is true, how can it be done?

Address yourselves just to that opening question, any member of the panel.

Mr. Danilov?

Mr. DANILOV. I think that is the case in the technology transfer programs. The ones that benefit the most are the taxpayers. The funding of the Federal technology transfer programs is designed to stimulate the national economy as well as to assist individual companies. I feel rather strongly that if you are going to have an effective technology transfer program, especially in the early stages, that the funding will have to come from the Federal Government.

However, I also believe that the individual firms benefiting from such transfer should contribute to some extent to the financing of such a program.

Mr. HOBSON. Senator Randolph, I would like to say that I agree with that. I think the start that has been made by NASA in developing our regional dissemination centers is an excellent thing. I think the regional dissemination centers have worked out very well. The only problem is that this is just not enough effort. I was very glad to hear Dr. Weimer point out that the center at Indiana University will soon be self-supporting.

I think that we can expect industry and business to pay for the service. But I don't think we can expect them to pay the full cost. I think we will have to invest something and provide subsidy to get the system going. After it is going, as in the case of Indiana University, I think we can expect industry to pick up more and more of the bill. But I think real efforts have to be made and real assistance has to be given personally by skilled and experienced people directly contracting business and industry. In many cases companies just do not know when to ask and what to ask, they frequently do not even know they need assistance or could use it. Somebody has to point this out. I think this will have to be funded to a considerable extent by the Federal Government.

Senator RANDOLPH. I don't want to preclude all panelists from commenting on all the questions I ask. Perhaps we might sort of separate them a little.

Dr. Weimer.

Dr. WEIMER. I just want to suggest that industry is quite willing to pay for, as I put it, the value added to these sources of information.

However, industry is not willing to pay for the experimentation that we have found necessary to develop a system which is then very useful to them. And I think it is in the area of experimentation and the development process that we need the kind of support that we have been able to receive from, in this instance, the NASA contracts.

Senator RANDOLPH. Thank you very much.

I remember recently that in the Subcommittee on Education hearing certain county superintendents were testifying. And after one of the gentlemen had read his formal statement I said, perhaps just as a matter of fact to begin the line of questioning, "Do you have any further suggestions other than what you have said before?"

And he said, "Yes; just keep the money coming, and we will do the job."

This seems to be an attitude of many people, that if the Federal Government keeps the money coming the job will be done. I am not attempting to be critical now. But that to him was the answer, really, that there would be no problem back home if the money was there. And the money, of course, was to come from the Federal Government.

So I think we have to keep thinking on this subject, because financial conditions may make us tighten our belts in the United States.

What you have been saying leads, I think, naturally, to what I now want to develop.

You have been thinking in terms of the need for the emphasis on personal contact. And I am wondering how many agents would we need in the United States.

I believe you said, Dr. Kimball, produce more per year, I think you used that expression. We naturally wonder what education these men would need, and what training they would need, and now, who would pay for the training?

Dr. Kimball, you might lead off on that.

Dr. KIMBALL. First let me say, Senator, that my testimony consisted mostly of an elucidation of the problem areas in technology transfer. These have come across my field of vision over the last 6 years largely because of the efforts MRI has been putting forth on

behalf of NASA. I want to make the point that we would not today know much about these problems had it not been for the funding by the Government, NASA, in particular. I think these would not have been as clearly earmarked today if the funding had been done by private sources.

As to how these people have been trained, it is more than formal training. What characterizes them is almost "body chemistry." One man gets satisfaction out of being a transfer agent, and the other man gets his out of seeing his name on the list of a large group of scientific papers. If I had to prejudge the type of man best equipped to be a transfer agent, it would be a man with 4 years of undergraduate experience in some field of technology, chemistry, engineering, or the like, hopefully then being exposed to the climate that I know exists, say, in the Graduate School of Business of the University of Indiana and a few others of that type. These people are then predisposed to want to get things done in the transfer field.

As to who would pay for them, I think that is a matter to be decided in the graduate schools of business. I can see internships for these men coming in laboratories like those of the Ford Motor Co. and the General Electric Co., which have had a leading role in transfer within their industry.

Similarly, a handful of such people might be exposed to the climate and point of view that Mr. Hobson expressed so well, in research institutes of the type of SRI and MRI.

Six years ago when this activity started not much was known either about the problems or the content of material to be transferred. Today a lot is known about the problems, and there have been splendid examples of progress and accomplishments.

I would like to say that it is hearings of this sort that give real visibility to these issues. And I will repeat my opening statement, that this issue we are facing may go down in the history books, if we surmount it, as one of the tremendous intellectual accomplishments of this part of the century.

It is not a simple problem, Senator.

Senator RANDOLPH. Thank you, Dr. Kimball.

As you spoke of chemistry I was reminiscing. I remember I wasn't very good in chemistry, partially because, perhaps, I didn't apply myself, and because it seemed that the laboratory work came in the middle of the afternoon and I needed to be outside rather than inside. Athletics had a greater appeal to me.

But I recall Dr. H. O. Burdick, who was professor of chemistry, seeing me there at my dirty sink—I didn't keep it very well. And he said rather sarcastically, "I don't believe you like chemistry."

And I said, "Not particularly."

And he said, "I doubt if you could tell me what H_2O is at this moment."

And I said, "Professor Burdick, if you don't mind my saying it, it is hell twice over to me."

The low grade I was to have gotten became much lower.

But I am telling this story partially for a reason, and that is that there does have to be the application to the subject matter in any of these fields that you have spoken of if the person who is doing the job

here is to really be helpful to others. He must be grounded, and he must be well informed, and he must be inspired.

Isn't that true, Dr. Kimball?

Dr. KIMBALL. That is true.

Senator RANDOLPH. If the message is to be taken. I think it is very important that we realize that fact.

Dr. KIMBALL. As I said in my testimony, Senator, all great accomplishments, whether they are in transfer or any other human endeavor, require champions. The few people I know in this country who are good transferers of technology have championed this idea. And this is their career.

Senator RANDOLPH. I fully agree. I remember what you were saying, Dr. Weimer, in your statement about Representative Roush. I don't want to argue with Representative Roush, because I have no right to do that. I admire him very much.

But I am not sure that he said what I think should have been said about the glamorization of the program. And I think it should stand on its own. I think I recall—and again I am not argumentative—when Mr. Webb used to talk about going to the moon, and therefore we will cure cancer.

Do you remember?

I am not trying to be facetious here, but I think what we have got to do is not to try to draw attention to what the subject matter is by moving into these indirect and fringe areas. And I think the glamorization could perhaps result in that which is negative in the long run rather than that which is affirmative.

I don't want any comment on this point that I am making, I am just giving it to you at this time. I don't want to preclude somebody else from talking on the subject.

Mr. Danilov?

Mr. DANILOV. I just want to comment on two aspects.

First, the matter of financing. I have no idea how much the Government is spending on technology transfer. But it seems to me that with greater coordination and better direction of efforts, perhaps the same amount of money could be utilized in a much more efficient way, thereby not requiring a substantial amount of additional funds.

The second point relates to manpower. I agree with the comments of Drs. Kimball, and Hobson, regarding the need for technically oriented people to serve as missionaries of application. I would like to point out that there are at least two examples of such people working rather effectively.

First, of course, is in the agricultural field. For many years, we have had people grounded in the agricultural sciences who have served as effective transfer agents.

The other category would be that of the applications engineer. Most companies that are selling to a technical market have men with engineering backgrounds on their staffs who receive their satisfaction not from discovering knowledge, but from applying it through the sale and servicing of instruments, materials, and other products. My feeling is that it is possible to find such people and to utilize them for the program we are discussing today.

I don't feel that the current programs are doing enough along these lines.

Senator RANDOLPH. Thank you.

Dr. Weimer?

Dr. WEIMER. I would just like to add that the very type person that Dr. Kimball described is pretty much the person who does the major amount of work in our center. For the most part this work is done by graduate students who have engineering or scientific undergraduate training who do this to help support themselves while they are taking advanced work in business administration or law or advanced work in one of the sciences.

Senator JAVITS. Mr. Chairman, may I be recognized very briefly?

Senator RANDOLPH. Yes, Senator Javits. You come with good news. And I would like very much for you to tell of certain activities in which you have been a participant today.

Senator JAVITS. I just want to report to the Chair that the State, Justice, Commerce, and Judiciary appropriations have just been provided by the Appropriations Committee. They show a material restoration of funds much closer to the budget amount for operation of the Office of State Technical Services. I will not give the figures, Mr. Chairman, because that should properly come in the report, but I think it fair to say that we have a direct connection between the great interest shown in this subject as reflected in these hearings, and the fact that the Appropriations Committee was convinced that this was so useful to American production that it should, at a time when we are cutting everything, literally have more money.

I think the Chair has every right to be gratified by this confirmation of the importance of these hearings from a committee which is as hardheaded as the Appropriations Committee, on which I have the honor to serve.

Senator RANDOLPH. Senator Javits, we know of your intense interest not only in the subject matter of these hearings, but your attention to proper funding. And I would say for all of us on the subcommittee that we will continue to follow carefully the work of the funding as it is set forth by the appropriations which are made.

Thank you, Senator Javits, for contributing this information and for your help in our work.

I am sure we can agree that insofar as all of us in Congress are concerned, we must try to understand what the feedback is from business users of the Federal technology transfer programs. I am not sure we know the ways to improve this.

Can you help us in your discussion today on this point? Do you have any comment?

Dr. KIMBALL. I will make a pass at that, Senator.

Senator RANDOLPH. I think someone said something here. Who was that? Somebody in one of the statements spoke about that experimental program.

It was Dr. Weimer. There is a timespan involved here, I would think, that we have got to consider, and how we can get more feedback, frankly, from the users.

Go ahead, Dr. Kimball.

Dr. KIMBALL. It is directly proportional to the confidence that the user has in the source of his information specifically. And the closer knit that relationship is, where the user regards the source as a trusted

source, and the elements of transfer are of high utility, then you see feedback in an undiminished quantity. I know from our own experience at Midwest Research Institute and the other NASA RDC centers particularly, the industrial feedback goes up many times per year. And there are hundreds of cases of users, many of them in small business, I suspect most of them in small business.

I will not forget, sir, that in 1957 I was appointed by President Eisenhower as the deputy chairman of a special conference working with Eric Walker, president of Penn State as chairman. The conference related to research and development for small business. And over the course of that period of time we talked with some 5,000 small business people. And one of the main findings of the conference—and I think it applies today even more so—is that small business does not need research and development, it needs the results of research and development. This is what we are talking about in transfer today, although it was not called transfer then, in 1957.

Senator RANDOLPH. Thank you, Dr. Kimball.

I think we are all aware of the fact that it is not quantity, it is quality. In a sense they can't go together, and quantity is certainly less effective than quality.

There is a final question which I think all panel members might wish to make response to before we close the hearing. I have heard that it is cheaper to, let's say, do a piece of R. & D. work over again, than it is to find the technology in our present information center. I don't know what you have to say to that.

But let's have a little discussion on it.

Dr. KIMBALL. The most expensive part of research and development is experiment, because one doesn't know whether he has to do the experiment once or 10 times. As someone once said, the best research person does the last experiment first. I would quarrel with that statement, Senator, that it is less expensive to do the research yourself than find the information. A really skilled person can find information if it exists in the literature, whether it is Federal or otherwise, much more effectively than he can do the research himself.

Senator RANDOLPH. I remember a few weeks ago talking to Henry J. Kaiser prior to the time he passed on. He passed on at 87. I talked to him in Honolulu when I was on a visit to Hawaii. I have known him for years, since he first became interested in West Virginia.

May I take just a moment to tell you this?

Ten years ago Kaiser came to West Virginia with a plant near Ravenswood in a rural area. And I can recall his speech that night when we honored him and his associates, because he had made the determination of the location. He said, we did not come here because of your broad river. There are other rivers just as broad. We did not come here because of your valley. Other valleys are just as wide. We came here really because of your people, the people who indicated that they would help us to make a success of this plant.

There are 3,500 men and women working there today, I think, the largest number of people under one roof of Kaiser. It is a large installation, and it is successful.

But a few weeks before he died he was still alert mentally, though not physically. And he said, "Go back and tell the people, especially

the young people, that there is so much yet to be done that we have only scratched the surface." And what you are saying here, Dr. Kimball, is an experiment on top of an experiment looking for the answer.

Any comment?

Mr. Hobson?

Mr. HOBSON. Senator, I would like to comment on your observation—or your question about it being perhaps cheaper to do research over than to find the results of existing research. I really don't believe that that is true. But there are two things that I would like to point out.

Senator RANDOLPH. Only in the sense that I said I had heard that.

Mr. HOBSON. I think that the information, the results of technology, are today being made available much more readily than they have been before. We owe a great debt to the Federal Government for making much of this information available in libraries and information centers and in the NASA regional dissemination centers. There are now a number of sources of information and they are operating very effectively.

I would like to emphasize again a point that I tried to make in my statement, that nearly always some additional development has to be done, there has to be some adaptation of the technology. Very seldom can we pick something off the shelf and use it. Nearly always there must be some additional development as far as commercial research is concerned before results can be used.

Senator RANDOLPH. Thank you.

Thank you very much, gentlemen.

This morning has been a productive one. It has been helpful to me, and I am sure it will be helpful to the members of the subcommittee.

We will begin tomorrow to hear the testimony of those agencies that are engaged in the responsibility for technological transfer. We will have witnesses from NASA, AEC, and the Department of Defense.

And on Thursday we will have witnesses from the Small Business Administration, and representatives of the Department of Commerce.

(Whereupon, at 12:15 p.m., the subcommittee adjourned, to reconvene tomorrow, Wednesday, September 27, 1967, at 10 a.m.)

TECHNOLOGY TRANSFER

WEDNESDAY, SEPTEMBER 27, 1967

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE AND TECHNOLOGY
OF THE SELECT COMMITTEE ON SMALL BUSINESS,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10 a.m., in room 1202, New Senate Office Building, Senator Gaylord Nelson presiding.

Present: Senator Nelson.

Also present: Blake O'Connor, professional staff member; Daniel T. Coughlin, minority counsel; and Richard A. Carpenter, Legislative Reference Service, Library of Congress.

Senator NELSON. Today the subcommittee on Science and Technology of the Senate Small Business Committee resumes hearings on problems involved in technology transfer. Senator Randolph will not be here this morning. He requested that I chair this hearing for him.

Testimony has already been taken from representatives of business users of technology, and from organizations active in the actual transfer process which links the sources of technical information to the users in industry and public programs.

Today we will hear from three agencies which between them generate a large portion of new federally funded scientific and technical knowledge.

Our first witness will be Dr. Richard Lesher, Assistant Administrator for Technology Utilization, National Aeronautics and Space Administration.

Dr. Lesher, if you would identify for the reporter your associates, you may then proceed to present your material in any way you wish, either extemporaneously or by reading it.

STATEMENT OF DR. RICHARD L. LESHER, ASSISTANT ADMINISTRATOR FOR TECHNOLOGY UTILIZATION, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, WASHINGTON, D.C.; ACCOMPANIED BY GEORGE J. HOWICK, DIRECTOR, TECHNOLOGY UTILIZATION DIVISION; AND MELVIN S. DAY, DEPUTY ASSISTANT ADMINISTRATOR FOR TECHNOLOGY UTILIZATION

Dr. LESHER. Thank you very much. On my right I have with me Mr. Melvin Day, the Deputy Assistant Administrator for Technology Utilization. On my left is Mr. George Howick, Director of the Technology Utilization Division.

I would like, as we handle questions and answers, to allow these gentlemen to participate as well as myself.

We intend to concentrate in our presentation to you today on the experience we, at the National Aeronautics and Space Administration, have had in operating our technology transfer program. We will draw from that experience certain lessons we have learned that may be useful to this subcommittee in your deliberations on the important issues before you.

I have submitted lengthy testimony, in writing, for your consideration. I intend this morning only to summarize that briefly so that we may have more time for discussion of some of the key questions you have posed in your excellent report, "Policy Planning for Technology Transfer."

That report, incidentally, is not only an excellent survey of the field but also an important contribution to the literature in technology transfer.

Statesmen have been concerned with the Federal Government's responsibility for and role in the transfer of technology since the Constitutional Convention.

In fact, the technological base of the new Nation was a central issue in the minds of the framers of the Constitution. Men like Thomas Jefferson and Benjamin Franklin were concerned over the "technology gap" of that era—the fear that the new Nation would not have the capital, the science, or the technology to compete with the well-developed European countries.

Their concern led them to consider many proposals for giving the new Nation a strong technological base from which industrial growth could be fostered. One proposal given especially serious consideration was for a "grand plan" that even included the establishment of a national university here, devoted to advanced technical education and to a national program for the dissemination of technical information.

Though this grand plan was not adopted, the debates surrounding it marked the beginning of a pattern that has continued through our history—a pattern of continuing concern by leading statesmen with the rapid and effective diffusion of scientific and technical knowledge. As you know, many active efforts have been undertaken from a variety of statutory bases.

The best known is that of the Department of Agriculture which, through its farflung enterprises, has been so successful that our farm industry's productive capacity has at times outstripped its market.

In the years since World War II, the Atomic Energy Commission has carried out a vigorous program for the dissemination of unclassified science and technology to encourage the development of industries related to nuclear power development programs.

And in the Space Act of 1958, the Congress specifically charged NASA with the obligation to "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

To help carry out that obligation the technology utilization program was initiated in late 1962 under the name of the industrial application program.

The National Commission on Technology, Automation, and Economic Progress, created for a 1-year life in August of 1964, was directed to:

* * * assess the most effective means for channeling new technologies into promising directions, including civilian industries where accelerated technological advancements will yield general benefits * * *

The Commission's report places in perspective the important role of technology in economic growth; makes an assessment of the availability and relevance of Government-generated technology; surveys existing programs; and assesses the Government role and obligation.

More important perhaps, it provides a body of theory, a set of objectives, and a context within which technology transfer programs can be carried out.

The NASA technology utilization program is consistent with the principles articulated in the report to the Bowen Commission.

Further, the NASA program came into being at a point in our history marked by very rapid advances in science and technology on an ever-broadening front.

Mr. Chairman, if we could stand for just a moment high above the stream of history to view it several decades at a time instead of the minute-by-minute way in which we do, perhaps additional perspective could be lent to our current discussions. For from that vantage point we would note that the size of the stream—the number of subdisciplines and specialties generating useful new knowledge—has multiplied within our lifetime.

The accelerating pace of technological change is an important reason for governmental concern with the transfer of technology. For in this rapid change—unless there exist some organized methods for making new technology available—many who could benefit from such technology will not find the access routes to it until the technology has become obsolete. Or, more serious than that, much useful new technology will not find its way into standard practice because those who originate it will have no efficient and meaningful way to communicate it to others.

In that setting, we at NASA recognize a dual obligation. One is the obligation for immediate action to transfer aerospace technology to those who urgently need it and will use it. The second is our obligation, as part of a research and development agency, to conduct R. & D. on new and improved technology transfer techniques.

For these reasons, the NASA technology utilization program has been conducted in an experimental mode, permitting the lessons of experience to guide us in making changes and modifications within the operating elements of the program.

This evolutionary approach is, at the same time, providing a body of knowledge and experience that we can pass along to other agencies and institutions. I would like to draw from that experience and discuss some essential ingredients of a technology transfer program.

The most important of these lessons is at the first step in the transfer process—the identification of useful new technology. Technology exists in many forms—in the minds and experience of scientists, engineers, managers, and technicians, in documents of many kinds; in not-yet-articulated concepts and understanding; in physical devices and systems. The documents will appear as patents, research reports, unanalyzed data, handbooks, trade press articles, papers in technical journals, proceedings of conferences and seminars, random notes of scientists and engineers, and countless other diverse 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 motivating innovators to report it; 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.

Some pioneering efforts of this type on a formal basis are underway. At NASA, for example, we have experienced men, whom we call technology utilization officers, at each of our major installations. These men are responsible for assuring that the professional personnel at their installations document and report the inventions, improvements, discoveries, and other technological advances—including computer software developments—generated in the course of their work. These are reported into a central system so that the widest practical access to these advances is made possible.

The technology utilization officer also has the responsibility to administer the new technology clause in all NASA contracts for research and development. This clause obligates the contractor to report to NASA all new technology first conceived or reduced to practice in the course of his work under that contract.

Senator NELSON. How are you assured that he does that?

Dr. LESHER. Well, you never have absolute certainty. But you assure to the best of your ability by working closely with the contractor, monitoring his work closely, by reading his regular progress reports.

Senator NELSON. Who reads them?

Dr. LESHER. The technology utilization officer.

Senator NELSON. Where is he?

Dr. LESHER. He is located in the field centers, the field installations of NASA, located all over the country, and he works very closely with the technical monitors, the people who are working with the contractor on a daily basis to assure that the primary mission of the contractor is completed on schedule within the best cost framework, and so on.

We have a clause in the contract which forbids payment until the technology utilization officer is assured in his own mind that all technology has been reported. Final payment on the contract cannot be made until that is done.

We believe it is necessary to rely on such an organized system, rather than chance, to make new technology available.

Senator NELSON. How do you define small companies?

Dr. LESHER. In this table we use the SBA definition.

Mr. HOWICK. 500 employees, except in those industries where the concentration ratio makes it lower or greater than 500.

Senator NELSON. Do you have the definition in mind for the record?

Mr. HOWICK. No, sir; we can submit it if you like.

Dr. LESHER. The basic definition as the SBA defines it, is 500 employees or less.

Senator NELSON. You mentioned membership. What organization were you referring to?

Dr. LESHER. In the regional dissemination centers which are established at university and nonprofit institutes.

Senator NELSON. And the total number of companies that is paying fees as members of the regional dissemination centers is 286 in the country; is that right?

Dr. LESHER. 286.

Senator NELSON. How long have these regional centers been established?

Dr. LESHER. Well, as I pointed out, they range in age from 5 months—the newest is 5 months old. The oldest is 54 months. In other words, their average existence is between 2 and 3 years.

Senator NELSON. What is the membership fee?

Dr. LESHER. The membership fees range from $150 a year up to as high as $18,000 per year. The fee varies based upon, No. 1, the size of the company, which relates then to, No. 2, the degree of service that the company demands. In other words, if it is a large company, and they have many divisions served, the cost will be greater.

Senator NELSON. Is this a flat $18,000 fee or do they also charge fees for specific requested service?

Dr. LESHER. In most cases this is a membership—flat annual membership fee, based upon experience with the company. In other words, in the first year, Indiana University, which was the first center, they experimented with two fees—one was $2,500, the other $5,000. They found that even the low fee of $2,500 kept some companies out, and $5,000 did not cover the cost of serving some of the largest companies. So based upon the user needs, and the degree to which they used the services, they have built in a sliding scale of fees for the companies.

Senator NELSON. As I understood the testimony, these dissemination centers must become self-supporting within a 5-year period.

Dr. LESHER. Yes, sir.

Senator NELSON. Are any of them self-supporting now?

Dr. LESHER. The Indiana center is nearly at that stage.

Senator NELSON. Do you have a breakdown—in your testimony—where the centers are located, and how many subscribing companies each center has?

Dr. LESHER. We have that, the latter, in the appendix to the formal statement for the record.[1]

Senator NELSON. From your analysis of the membership of each dissemination center, and the fees being paid, can you make any prediction as to how rapidly all of the centers will become self-supporting, or whether some of them appear to be foundering?

Dr. LESHER. The basic proposition—let me just back up to answer that. The basic proposition was that we would put in the seed money for a period of 3 to 6 years, to get them started. If industry was not interested in these services to an extent sufficient to pay for the value added by the services, then we would close them down.

Our prediction—getting back to your question—is that most if not all of these will be self-supporting within that general guideline.

On the other hand, the other part of your question—yes; at least one is floundering and having difficulties.

Senator NELSON. At least one?

Dr. LESHER. At least one of these centers is having difficulties.

Senator NELSON. Where is that?

[1] See p. 100.

Dr. LESHER. This is one of the ones in the Midwest.

Senator NELSON. You don't want to name it?

Dr. LESHER. I would rather not. If you don't mind—I would rather not add to their burdens.

Senator NELSON. I think a comment from you might cause them to flop completely; is that it?

Dr. LESHER. Let me say this, Senator. This is an extremely difficult task. It is really revolutionary to get a university involved with industry, building this bridge between Government and industry on a fee basis. You have to change such fundamental things as the way of doing business between a company which normally will give a gift, if they do anything with the university, to changing a company policy to permit them to purchase a service from a university.

Senator NELSON. What is the cost of operating one of these dissemination centers? Do you want to use Indiana, for example, or don't you want to name any particular one?

Dr. LESHER. Well——

Senator NELSON. As I understood, that one now is almost self-supporting, according to your testimony.

What I am getting at is how much money are we talking about?

Dr. LESHER. Well, in our total budget for this portion of our program, for the nine centers, it is $1.8 million.

Senator NELSON. An equal amount going to each center?

Dr. LESHER. No, sir.

Senator NELSON. An ascending or descending scale depending upon the success of the particular center?

Dr. LESHER. Well, it depends upon a number of things. The nature of the program—because each one is experimental, carrying out experimental activities. It depends also on the geographic location, and hence the industrial base of that region. And some of these are small—a hundred thousand dollars a year being the smallest one.

The largest one is approaching a half million dollars per year.

Senator NELSON. Would you say about 45 percent of the members in terms of number are small businesses?

Dr. LESHER. Yes, sir.

Senator NELSON. How do you ever expect businesses of 200 or 300 or 100, who are doing various kinds of developmental work—how do you ever expect them to benefit from this program?

Dr. LESHER. The lowest fee for these services is $150. I would think that the very smallest company can afford this. One of the basic problems is acquainting small firms with the services which are available.

Senator NELSON. Wouldn't it cost a small business much more than that? One hundred and fifty dollars is the fee to use the facilities. But if you are going to use it, you would have to have a full-time person at $10,000 or $15,000 or something.

Dr. LESHER. No, sir. This is a misinterpretation of how the system works. The system at these dissemination centers are staffed by university people, either graduate students or faculty. And the services provided to the companies are provided by the university personnel within that basic fee.

The company man does not have to send a technical man to the center to get these services. All they need is a good, clear definition

at the outset of what the technical interests of that company are, the construction of what we call technical interest profiles, and then the company will be served on a regular basis without a great deal more effort on its own part. After they define it, the centers will provide searches, and they will package this information, and add value to it, and provide this to the company through the mail.

Senator NELSON. That assumes that you can really have a center in which a group of people are able to analyze what a thousand varieties of companies might need. I doubt whether that can be done—I do not care how talented they may be. Here is a company working in a particular field, and the person trying to furnish the information to the company does not have the remotest notion of what that company's function or problems are, except from reading a memo.

It seems to me the furnisher of information has to understand what the user wants, and even if he understands what the user wants, if he does not know the business, he would not recognize a piece of collateral information that might be adaptable to this business.

Dr. LESHER. Exactly. Permit me to explain just a little more about the concept of the technical interest profile.

Dr. Weimer, who headed the Aerospace Research Applications Center, testified yesterday about the characteristics of the people working in these centers. The people are graduate students in business administration. They all have undergraduate degrees in science or engineering. So they are uniquely equipped, with this combination of background. These people then act as special transfer agents for a select group of companies, each one handling maybe five or six companies, or five or six technical interest areas within a company. And it is their job to get to the company—not the other way around, the company coming to the center—it is their job to know that company, know its technical needs, by visiting, and by defining these technical interest profiles, by knowing just what the company is planning to do in product development, processing improvement, quality control, and what have you. This is why I made the point earlier that it is absolutely essential to have institutions like universities, nonprofit institutes, involved, because this intimate relationship of defining technical needs is in the process of so doing disclosing proprietary information to the intermediary.

Senator NELSON. In what way—as to all of the various industry publications, scientific publications, technical publications—in what way is the material available to them?

Dr. LESHER. Well, in a number of ways and I will give you a more complete statement as I proceed through the statement. But basically we utilize all of the normal Government techniques.

Let me emphasize that. All of our publications are available through the Government Printing Office, through the Department of Commerce Clearinghouse for Scientific and Technical Information, through mailing lists, and working very carefully with the trade press.

Last year alone we had more than 700 articles in the trade press in the United States announcing the availability of NASA technology to industry. In our own research of the transfer process, we have found that industry relies very heavily on the trade press as one channel for acquiring new technology for that firm. And this is why we have experimented with that means of disseminating technology.

Senator NELSON. As you know, there is a trade association for every industry, every industry in America. And I guess some standing by that do not represent anybody yet, but will as soon as they are available.

They all publish. Some of them are very good publications, highly sophisticated.

Can the scientific editor of any specialized publication come to the dissemination center and make inquiries, get service, get information free of charge for use in his publication?

Dr. LESHER. Absolutely. And it is a good question. We thought so much of that point that earlier this year we had our internal management review for the administrator run a review—which goes through the entire program in quite some detail. We later scheduled a rerun of that program review, and at our specific invitation, a large number of representatives of the trade press and trade associations came in and heard this, and saw demonstrations of technology and so on.

We then offered to them two means of acquiring this technology on a regular basis for use as you suggested. Either they could go through the dissemination center, and get these sophisticated services, or they could receive from the Government regular mailing notifications of the availability of the technology in their particular field.

Senator NELSON. Supposing it is a trade association of tool and die makers, and their representative comes with all kinds of inquiries directly associated with problems of this industry. Is that service free?

Dr. LESHER. If it is a service—the service you are suggesting—if it is a request for us to identify the publications which are pertinent to those questions, then the service is virtually free. It is limited only to the cost of the publication.

If, however, more importantly, they want to bring the expertise from related areas, and they want to search not only that narrow field, but they want to find out if there is a solution in mechanical engineering for a medical problem, then this is a much bigger problem. And there we suggest that they get involved with a dissemination center, because again, that kind of service demands an extra service, an extra packaging function for the user.

Senator NELSON. I was assuming they had to go to the dissemination center. Do they get any service there they want? What do they pay for it?

Dr. LESHER. I am sorry?

Senator NELSON. A representative of a particular industry goes and wants information, any information he can find that may be beneficial to the industry that belongs to his association. How do you handle that situation? They may have 50 companies, a hundred companies, a thousand companies. They may make one specialized item—it does not matter.

How do they use the information? What do you charge them? How do you handle that?

Dr. LESHER. We charge them the cost of the publication, if we can readily identify those publications relevant to their interests.

If they go to the dissemination center for a more useful, sophisticated service, they will pay a fee like other clients.

We have found that the fee structure is one of the most important elements in our system. We have found that people do not care much about things they get free—they distrust it. We have found that the market mechanisms work pretty well. If you put the dissemination centers on a competitive basis, and you charge people a fair price for the services they receive, the services are much more useful. It puts pressure on both the user and the transfer agent, to produce good services. This is one of the strong convictions that we have in this program.

Senator NELSON. Supposing a person wants to come and use the services at the dissemination center, and he does not have any notion really what he is looking for.

Dr. LESHER. Every one of our centers has undertaken on an experimental basis to provide services free for a period of time to answer that question.

Senator NELSON. How is your information compiled? Do you have indexes and publications, like a library?

Dr. LESHER. The basic backbone of our system is the scientific and technical information system which was developed for NASA for on-going missions. And this system is a very advanced system, embracing about 500,000 documents.

These documents—and this storehouse, I might add, is growing at the rate of 6,000 documents per month. These documents are filmed on microfilm and they are indexed on computer tapes. And you can see this kind of service is sophisticated and not free. So the basic service is provided from that information resource that we had built for another purpose. Once it exists, then it is easy for a marginal investment to use it for other purposes as well.

Senator NELSON. I guess I better let you proceed. We have two other witnesses, and I have a commitment at 12 o'clock. I have several questions here I have not asked. But I am assuming that the staff may submit the questions, and you will respond to them in writing for the record.

Dr. LESHER. Yes, sir; we would be very pleased to.[2]

Senator NELSON. All right. If you would proceed quickly and finish your testimony.

Dr. LESHER. The discoveries of extreme magnitude, those that lead to the creation of whole new industries for example, generally have sufficient inherent force to bring about their own exploitation. But the incremental improvements in technology, which individually have seemingly lesser significance but which in composite underpin our industrial might, are less easily brought to the attention of all who can use them. It is clear that any program to transfer technology must give emphasis to identifying and communicating incremental advances.

We at NASA have found our contractors generally willing to accept this responsibility once there is a comprehensive understanding of the reporting requirements. But full implementation of such reporting programs is an extremely difficult task. Many of those who develop useful new technology have never heretofore had the responsibility to document and communicate it, and such habits are obviously difficult to change.

[2] See p. 120.

But our continuing educational and motivational efforts are paying off on substantially increased reporting of new technology by NASA contractors. The additional cost of bringing about these increases in reporting, in our experience, amounts, on the average, to approximately one-half of 1 percent of the total direct scientific and engineering effort under the contract.

A recent study showed that, in business practice, innovation is more often the result of recognizing and adapting an idea than of inventing a brand new one. This research found that half of the 560 innovations were based on information that originated outside the company that brought about the innovation. In a number of cases, the information was seemingly of relatively minor significance—but proved to have important benefit to the companies that used it.

For such reasons, NASA places heavy emphasis on the identification and documentation steps in the transfer process.

The second critical lesson from our experience resolves around the importance of a programatic approach to technology transfer. The technology transfer process can be viewed as a system.

The system has a number of critical design parameters. These include—

It must be responsive to the varying needs of a wide variety of users, whose requirements will change with time and task.

It must be capable of providing to the user information of great variety culled from a multiplicity of sources.

It must develop from experimentation. The nature of technology transfer is complex and not yet fully understood. There is still much to be learned—and one of the primary underpinnings of our program at NASA is the deliberate experimental search for improved approaches to and methods for the transfer of technology.

The system must incorporate processing functions that add value to the information. These include screening, evaluation, interpretation, packaging, and synthesis.

It must deliver services that meet the tests of significance, relevance, currency, ease of accessibility, comprehensiveness, intelligibility, and economy.

It must have—as an integral part of its basic design—measures of its utility. If the services provided are truly important, the user will begin to bear at least a portion of the cost of making the service available.

There must be a feedback mechanism, permitting user needs to be transmitted to, and interpreted for, those who supply information into the system.

And there must be, designed into the system, a means of exchanging services among the dissemination mechanisms as well as a means of exchanging information on technology transfer methodology.

A third critical lesson we have drawn from our experience is the importance of a proper organizational context for the leadership and coordination of a technology transfer mission.

We have indeed been fortunate to be located in an organizational structure, at NASA, which has emphasized technology generation and the application of science from the beginning of the agency. As you

know, our Office of Space Sciences and Applications and our Office of Advanced Research and Technology are parallel to the Office of Manned Space Flight in the NASA structure. This emphasizes the importance that NASA leadership has placed on the generation of useful technology and on the early application of new knowledge, which results from the advanced research activities of the agency.

When Mr. Webb established the NASA technology utilization program, he also provided it with the visibility and organizational location necessary to achieve effectiveness. This program has always been headed by an Assistant Administrator and has always been given strong support by the Administrator himself.

The effective transfer of technology cannot be accomplished as a small and separate function of an organization. Absolutely essential is the commitment of the total agency to the function.

For that reason, Mr. Webb organized the Office of Technology Utilization as a functional staff office headed by an Assistant Administrator as the functional manager. Within NASA, functional management means "the provision of centralized professional leadership and continuous monitoring, evaluating, and reporting to senior agency officials or agencywide policies, procedures, and operational practices in a given functional area."

The functional manager is authorized to "establish standards, procedures, and operating guidelines controlling the manner in which the functional effort is conducted throughout the agency, coordinating proposed actions and directives with institutional and installation directors and other functional managers."

Earlier this year the Office of Organization and Management, headed by an Associate Administrator, was created. Within this Office are the functional staff Offices of Administration, Industry Affairs, University Affairs, Special Contracts Negotiation and Reviews, and Technology Utilization. This permits us to provide day-to-day linkage between those functional offices directly concerned with our major ways of doing business; that is, the internal decision processes, and our relationships with private industry and the university community. By having Technology Utilization as part of this strong functional cluster, the technology utilization program is tied in directly to the major programs and administrative processes of the agency.

We are convinced that a program to transfer technology effectively cannot be achieved without such commitment on the part of the responsible agency.

An additional lesson from our experience relates to interagency cooperation. For a national program to be effective demands the closest kind of cooperation among the agencies involved—and, in the case of technology transfer, the number of agencies presently or potentially involved is very large.

As part of our technology utilization program, we have cooperative arrangements with nine other agencies on a continuing basis. These include the Atomic Energy Commission, with whom we carry forward a joint program to disseminate technology emanating out of AEC programs to achieve economies of scale and avoid duplication of effort.

With the Department of Defense, we have agreed upon a number of key standards for information handling and information packaging,

thus permitting compatibility between the important DOD information resource and our own.

With the Office of State Technical Services in the Commerce Department, we are in almost daily contact, planning, programing, and coordinating with one another so that our two programs reinforce one another to obtain the maximum service to industry for the available resources.

We have mounted, jointly with the Small Business Administration, an aggressive program to transfer aerospace technology to smaller companies. Together we have conducted several pilot projects and we are currently in the midst of a joint effort that is proving most beneficial. This effort is the joint sponsorship with SBA of a series of conferences to explain the relevance of Government generated technology to the needs of industry and to inform industrial management of the availability of technology transfer services from governmental programs. This series of conferences, cosponsored by NASA and SBA, is carried forward with the cooperation of the Atomic Energy Commission, Commerce Department Office of State Technical Services, Smithsonian Institution Science Information Exchange, National Referral Center of the Library of Congress, and others.

A fifth extremely important lesson from our experience relates to the need for specially skilled people to serve as transfer agents.

A message is more likely to gain understanding and response if it fits the pattern of experiences, attitudes, values, and goals of the receiver. True communication is dependent on a number of forces, and the sender of the message can really only control a few of them. He can shape his message, and he can decide when and where to introduce it. He cannot control the environment in which the message is received and in which response takes place, the attitudes and personality state of the receiver, or the receiver's group relationships, standards, objectives, and priorities.

To perform the technology transfer mission well, we must learn considerably more about both man and machine. We must, as a matter of priority, find, educate, and motivate more people to perform the more imaginative portions of the work.

Sixth, our experience has indicated that great importance must be placed on employing the traditional "trusted source" institutions to provide technology transfer services to industry.

Industrial problems, objectives, and long-range plans are, by necessity, proprietary. To apply relevant new technology to those problems, objectives, and plans demands that some knowledge of them be provided to the person or organization providing the service. Equally important, the source of the information must have a demonstrated high credibility rating if industry is to rely on the information for decisionmaking.

That is why we at NASA have relied so heavily on the service-oriented universities and not-for-profit research institutes to provide the bridge between the information base and the information user.

This has been a difficult task for the organizations involved, but they have made good progress in the face of many obstacles. Permit

me to report on the progress of the regional dissemination centers sponsored by NASA.

To solve a given problem in one context may require the pulling together of knowledge developed for a dozen other purposes, adaptation of that knowledge to the specific situation, and often, the creation of new knowledge to round out the package so it can be applied.

The delivery of tailored packages of knowledge in response to user needs is the aim of the experimental regional dissemination centers established by NASA. Nine centers, each one different, now exist. They range in age from 5 to 54 months.

They are obligated to become self-supporting in 5 years or less on the basis of industrial fees for services rendered.

They are located at universities or not-for-profit research institutes.

Each incorporates some unique features and experimentation.

All are oriented toward fulfilling the service role of their institutions, as well as their research and teaching roles.

All are supplied by NASA with the information collected by the Scientific and Technical Information Division and with that Division's expertise in information retrieval.

The regional dissemination center not only transfers technology; its broader purpose is to educate industrial management in the use of externally generated knowledge. The RDC performs this function via a range of services—including assistance in problem and objective definition, retrospective literature searching, provision of current awareness services to keep technical people updated in their fields of interest, and more recently, management technique services to keep management people updated in their fields of interest, calling client companies' attention to product developments or process improvements, and provision of information on management sciences and management techniques emanating from large Federal programs such as those of NASA. In such ways, the Regional Dissemination Centers add value to the basic information. The client companies pay for this added value rather than simply for the information itself.

The various services offered by the RDC's have proved useful to companies in many ways.

In the early days of these centers, many observers felt they would prove useful only to giant companies with large technical staffs. Recent experience, however, has indicated that smaller companies too can effectively use these services. Small company membership has grown to 45 percent of the total membership.

Seventh, agencies charged with the responsibility for technology transfer must assume, our experience indicates, an entrepreneurial attitude. They must continually seek new and better ways to enlarge the return on the national investment in research and development by encouraging additional uses for the results of that R. & D.

Senator NELSON. May I interrupt a moment? These are inquiries from business?

Dr. LESHER. Yes, sir. These are inquiries from businessmen after they have identified the publications announcing technology which they believe to be relevant to their needs.

Senator NELSON. Do you have a breakdown of who they are? I do not mean by names. The size of their business, nature of the industry.

Dr. LESHER. I do not think we have it compiled that way, but I think we could. We could give you a rough cut of that for the record.

Senator NELSON. I think it might be valuable for the record to see who is making the inquiry, and who is not, and what is the size of the organization, and how much repetition from one industry, or what type of industry is making the inquiry. If it is in a form that can be broken down for the record, I think those 10,000 inquiries broken down as to the type of industry, the size of industry, and the repetition, would be a valuable source of information. Among other things it would be valuable for determining who is and who is not requesting, and why not, and what one might do about getting requests or really getting information out to those who are not using it.

Dr. LESHER. I think we can give you a very good response to that after some effort. The only part of your total question was the repetition. I do not know that we can identify which companies or people are coming in continually, very easily, because our system identifies the field center where the innovation was developed. So one company may be coming in a dozen times, but in each case coming in at 12 different points. And we might not know that. But that is a small matter, and we will try to handle it for you.[3]

I would say in conclusion that we have tried to give a very positive assessment of an area that has come a long way in the last 5 or 6 years. There is some concern about the redundancy, or concern or worry about duplication of effort. I believe this is a very positive thing, if it is kept to a minimum. But I think it is wonderful compared to the situation we have here today, to what was happening in this area 5 or 6 years ago.

Technology transfer, technology utilization, these were words that were nonexistent. And now we have impressive testimony from a large number of agencies of how hard they are working on transferring the results of Federal R. & D. programs to industry.

I think that is remarkable progress in a period of 5 or 6 years.

On the other hand, we have a long way to go. We have not answered all the questions or solved all the problems. But we are responding to those just as actively as we can.

Thank you very much.

Senator NELSON. I just might say—one serious problem that I think confronts us in this area is the question of who uses it. As in all situations in the country, as things become more complicated, more sophisticated, the advantage continues to swing to the big and the powerful and the rich and those with resources. There isn't any question in my mind but what the aerospace industry or the auto industry or the power industry or what have you can make as full use as can be made out of this information, and that they can assign people to the full time, and they can evaluate it, and they can do all kinds of things, which increases their advantage over the small business.

So without having any knowledge about this at all, not being familiar with what you are doing, this being my first exposure to it, I would think the committee might be interested along the way somehow in finding out whether a small business is utilizing this—and obviously

[3] See p. 120.

they cannot utilize it as well as big business—and what might be done to give more assistance to the small business.

A large corporation has its own R. & D. program, has all kinds of personnel, and to add a number of people for the purposes of utilizing this information and having them work on a full-time basis, it is no problem. For a small business it is impossible. And it may very well be that NASA and Defense and so forth ought to be beefing up some aspects of this dissemination, doing for small business more of what big business can do for itself.

I do not know, but I suspect this is a problem, and that we might, by disseminating this information, do a lot of good for science and technology in the country, but at the same time be destroying the competitive position of small business as we go along.

Dr. LESHER. Yes, sir. I agree with you very much on that statement. Your surmise bears out in fact that large companies are equipped to very quickly utilize these resources. But that was one of the basic considerations in establishing regional dissemination centers, so that they could assist small business, because—I think even before the technology utilization program came into existence—we found that one of the critical barriers facing small business was their inability to interpret technical information if they did get it.

So this is the role of the personnel working in those dissemination centers.

Now, another front we are working on to help the small businessman is with the SBA. We have two major programs, which have been initiated within the last year and a half. One is a series of technical conferences, in cooperation with the SBA and other agencies around the country. And the second program is one where the SBA personnel operate as extensions of the regional dissemination centers, and they select small business firms in their areas, and they serve to interpret the technology that comes from the dissemination centers. In both of these programs—which I would like to submit a summary of these two programs for the record—I think you will see a remarkable receptivity on the part of the small businessman.

Senator NELSON. There is another approach that might be worth considering.

There are in every industry experts or those who know all there is to know at the present time. We have used retired businessmen as consultants to business in foreign countries, as consultants and advisers to businesses in this country, both through the Government and privately. It might be worth exploring—the possibility of getting very able retired people, retired businessmen, who know all about the industry, to go around to the dissemination centers, men who talk the language of the small business involved, who have been highly successful, to be consultants and advisers. I do not know, but I think it has been successful elsewhere, and it might be successful here.

Dr. LESHER. I would say that at the outset of the technology utilization program, we had an industrial advisory board which consisted to a large extent of small businessmen. It retains some of the more industrious of those people throughout the years, as consultants to advise us on the program, how it might be modified and tailored to the individual needs of the small businessman.

We have also had consultants from the SBA working very closely with us, and the dissemination centers have done the same.

Mr. HOWICK. We currently have an experimental program going on in the Boston area, where the SCORE people of SBA are working with one of our regional centers and one of our field installations in an attempt to interpret NASA technology for the smaller companies in that region. If the engineering- or science-educated people in the SCORE complex could be enlarged, we could duplicate that experience elsewhere in this country.

Senator NELSON. Thank you very much.

I guess we had better conclude your testimony here. I have taken up an hour with your testimony, and I only have less than 30 minutes each for the next two witnesses. Thank you very much.

You will probably get some staff questions, because there are a number we are unable to cover because of the time limitation.

Dr. LESHER. Thank you very much. We appreciate the committee's interest.

(The prepared statement and supplemental information submitted by Dr. Lesher follow:)

STATEMENT OF DR. RICHARD L. LESHER, ASSISTANT ADMINISTRATOR FOR TECHNOLOGY UTILIZATION, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Chairman and members of the subcommittee, we intend to concentrate in our presentation to you today on the experience we, at the National Aeronautics and Space Administration, have had in operating our technology transfer program, drawing from that experience certain lessons we have learned that may be useful to this committee in its deliberations on the important issues before you.

But, before we move into our specific experience, perhaps we might take just a few minutes to place this present deliberation in historical perspective.

Discussions of the U.S. federal government's responsibility for and role in the diffusion of knowledge, including the transfer of technology, date back to the Constitutional Convention.

In fact, the technological base of the new nation was a central issue in the minds of the framers of the Constitution. Men like Thomas Jefferson and Ben Franklin were well aware that European governments in the eighteenth century had often supported scientific and technological endeavors. They were concerned over the "technology gap" of that era—the fear that the new nation would not have the capital, the science, or the technology to compete with the well developed European countries.

Their concern led them to consider many proposals for giving the new nation a strong technological base from which industrial growth could be fostered. One proposal given especially serious consideration was for a "grand plan" that even included the establishment of a national university here, devoted to advanced technical education and to a national program for the dissemination of technical information.

Though this grand plan was not adopted, the debates surrounding it marked the beginning of a pattern that has continued through our history—a pattern of continuing governmental concern with the rapid and effective diffusion of scientific and technical knowledge. As you know, many active efforts have been undertaken from a variety of statutory bases.

Explicit recognition of this federal responsibility is embodied in the Constitution, which gives Congress the power to "promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." This provision, of course, is the basis of Federal copyright and patent protection.

An interesting case which established the government's duty to disseminate technology arose directly from the first patent law, passed in 1790. The administration of patent law was the responsibility of the Secretary of State, then Thomas Jefferson.

One of the first patent applications was for "a mixture which was supposed to help make salt water fresh (through a distilling process.)" Jefferson conducted the examination for the patent application, himself. He proved by experiment "that the fresh water came from the distilling process, long known and used at sea, and that the mixture added did not enhance its efficiency."

Nevertheless, Jefferson directed that instructions for building an evaporator be printed at government expense and distributed to all shipmasters.

That Jefferson should order the dissemination of the knowledge thus incidently called to his attention emphasizes his belief that the Federal Government had a duty to promote the general welfare by making technological information available to those who could use it.

From that point forward we have seen a long list of specific actions by the Congress which gave further substance to the principle of Federal support of science and Federal dissemination programs. The best known is that of the Department of Agriculture which, through its far-flung enterprises, has been so successful that our farm industry's productive capacity has at times outstripped its market.

In the years since World War II, the Atomic Energy Commission has carried out a vigorous program for the dissemination of unclassified science and technology to encourage the development of industries related to nuclear power development programs. The AEC has provided various consulting services and training programs and has recently established offices of industrial cooperation at its major laboratories to serve as a bridge between laboratory discovery and industrial application.

Professional efforts to provide our own agency with scientific and technical information support date from the earliest days of NACA. And in the Space Act of 1958, the Congress specifically charged NASA with the obligation to "provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

To help out that obligation the Technology Utilization Program was initiated in late 1962 under the name of the Industrial Application Program.

This has been only a brief historical review of legislative precedents and the obligations of a few selected Federal agencies to identify, evaluate, disseminate, and otherwise assist in the transfer of technology. It would not be complete without mention of the National Commission on Technology, Automation, and Economic Progress, often called the Bowen Commission, for its chairman. This Commission was created for a one-year life in August of 1964 and, along with three other primary functions was directed to:

". . . assess the most effective means for channeling new technologies into promising directions, including civilian industries where accelerated technological advancements will yield general benefits . . ."

The Commission's report places in perspective the important role of technology in economic growth; makes an assessment of the availability and relevance of government-generated technology; surveys existing programs; and assesses the government role and obligation.

More important perhaps, it provides a body of theory, a set of objectives, and a context within which technology transfer programs can be carried out.

The NASA Technology Utilization Program is consistent with the principles articulated in the report to the Bowen Commission.

Further, the NASA program came into being at a point in our history marked by very rapid advances in science and technology on an ever-broadening front.

Mr. Chairman, if we could stand for just a moment high above the stream of history to view it several decades at a time instead of the minute-by-minute way in which we do, perhaps additional perspective could be lent to our current discussions. For from that vantage point we would note that the size of the stream—the volume of scientific and technical knowledge now in existence—is about double what it was only two decades upstream. And we would note that the number of tributaries from which new knowledge is flowing into the stream—the number of subdisciplines and specialties generating useful new knowledge—has multiplied within our lifetime.

The accelerating pace of technological change is an important reason for governmental concern with the transfer of technology. For in this rapid change—unless there exist some organized methods for making new technology available—many who could benefit from such technology will not find the access routes to it until the technology has become obsolete. Or, more serious than that, much useful new technology will not find its way into standard practice because those

who originate it will have no efficient and meaingful way to communicate it to others.

This time in history is also marked by a dichotomy between the technologically sophisticated industries and many technologically lagging firms—an internal technology gap, if you will. It is not really a gap, however, but more of a spectrum—with companies strung out all along its length, but with the heavy cluster of companies far behind those few at the leading edge.

In that setting, we at NASA recognize a dual obligation. One is the obligation for immediate action to transfer aerospace technology to those who urgently need it and will use it. The second is our obligation, as part of a research and development agency, to conduct R&D on new and improved technology transfer techniques.

For these reasons, the NASA Technology Utilization Program has been conducted in an experimental mode, permitting the lessons of experience to guide us in making changes and modifications within the operating elements of the program.

This evolutionary approach is, at the same time, providing a body of knowledge and experience that we can pass along to other agencies and institutions.

The most important of these lessons is at the first step in the transfer process. We call this the Identification step. Technology exists in many forms—in the minds and experience of scientists, engineers, managers, and technicians, in documents of many kinds; in not-yet-articulated concepts and understanding in physical devices and systems. The documents will appear as patents, research reports, unanalyzed data, handbooks, trade press articles, papers in technical journals, proceedings of conferences and seminars, scrawlings in the notebooks of scientists and engineers, and countless other diverse forms.

The chances of finding it will not be good unless at least two conditions are met: (a) capable people are assigned the task of seeking it out and motivating innovators to report it as their primary responsibility; 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.

Some pioneering efforts of this type on a formal basis are underway. The Science Information Exchange, for example, has elicited the effective cooperation of many segments of the Government community sponsoring and conducting research in the life sciences and other disciplines which bring to SIE's attention descriptions of their current ongoing R&D activities. SIE assigns professional analysts to the task of documenting and categorizing this information, so that it forms an accessible body of information on who is presently doing research on what. This body of information is useful to the scientist—and to some technologists—as a means of referring him to others who can exchange useful information with him.

The NASA Technology Utilization Program provides another model. We have experienced men, whom we call Technology Utilization Officers, at each of our major installations. These men are responsible for assuring that the professional personnel at their installations document and report the inventions, improvements, discoveries, and other technological advances (including computer software developments) generated in the course of their work. These are reported into a central system so that the widest practical access to these advances is made possible.

The Technology Utilization Officer also has the responsibility to administer the New Technology Clause in all NASA contracts for research and development. This clause obligates the contractor to report to NASA all new technology first conceived or reduced to practice in the course of his work under that contract. 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.

In a society as complex as ours, there are considerable elements of luck and coincidence in the meeting of the producer of new knowledge with the potential user. But to rely on mere chance to bring about utilization of new knowledge would seem to be a most inefficient means of obtaining the maximum return on our large national investment in research and development.

Since early and widespread use of new technology can provide numerous national benefits, it is in the national interest to effect means of shortening the time gap between the discovery of new knowledge and its use. To do that requires systematizing communication between those who generate new technology and those who can apply it to meeting unmet human needs.

And in a society structured such as ours—a structure that encourages increased specialization—traditional means of communicating no longer suffice. Specialization within disciplines and fragmentaton of manufacturing activities have not only made it increasingly difficult to communicate across industry and disciplinary lines—it has become extremely difficult to communicate among fields of specialization within a single industry or discipline.

And just as one innovation or bit of new knowledge can have applicability in numerous areas, so also the development of a new device or system may require inputs of knowledge from a multiplicity of endeavors. Knowledge is not provincial—but people sometimes tend to be. While new technology may have utility in diverse areas, it is likely not to be recognized unless deliberately brought to the attention of innovative people working in those areas, in an understandable form, and at a time when it can be given sufficient evaluative attention. Thus it must be identified, documented, and reported into an accessible system which is known to exist by those who might use it.

Because a capability exists does not mean it will be used. When Baird called on the Marconi Company, he was told they could find no reason to be interested in television. Optimum utilization of new knowledge will not take place as a completely natural process.

The discoveries of extreme magnitude, those that lead to the creation of whole new industries for example, generally have sufficient inherent force to bring about their own exploitation. Like the gold coin in the coal bin, they are easily distinguished. But the incremental improvements in technology, which individually have seemingly lesser significance but which in composite underpin our industrial might, are less easily brought to the attention of all who can use them. It is clear that any program to transfer technology must give emphasis to identifying and communicating incremental advances.

To do this demands acceptance of responsibility by all those who work in governmental programs—directly or under contract or subcontract. Those who generate new knowledge at public expense must accept a part of the responsibility for communicating that new knowledge to others who can use it. All those concerned with research and development must accept responsibility for documenting and communicating their results in the same spirit that they accept responsibility for the R&D itself—for the two functions are inseparable. Doing less will obviously lead to fragmented and ineffective science and technology.

We at NASA have found our contractors generally willing to accept this responsibility once there is a comprehensive understanding of the reporting requirements. But full implementation of such reporting programs is an extremely difficult task. Many of those who develop useful new technology have never heretofore had the responsibility to document and communicate it, and such habits are obviously difficult to change. Historically, the research report, the scientific article, and the conference or seminar have been moderately effective for transferring scientific information. They have been relatively ineffective for transferring technological information because there has been no long tradition of formally recording technology. Production engineers, lab technicians, master mechanics, and instrument men, for example, have not conventionally been expected to write technical reports on their work. Consequently, a great deal of innovative technology has never entered into the formal information-transfer cycle. It diffused only slowly, if at all, to many of those who might use it.

But our continuing educational and motivational efforts are paying off on substantially increased reporting of new technology by NASA contractors. The additional cost of bringing about these increases in reporting, in our experience, amount, on the average, to approximately one-half of one percent of the total

direct scientific and engineering effort under the contract. This seems a small price to pay for the opportunity of bringing about multiple secondary uses of the technology so identified, documented, and communicated.

Technology emanating from government programs is an important national resource. It is beginning to be recognized as one of the critical factors in speeding regional economic growth. Only recently have economists devoted much attention to casual relationships in economic growth. And even more recent has been the attention to measurement of the contribution of technology to the rate, volume, and direction of economic growth. The few studies that have been made all point very emphatically to technological advance as a critical factor.

For example, Robert M. Solow has estimated that of the total increase in U.S. output per man-hour from 1909–49, only one-eighth was due to the increase in capital investment while seven-eighths was due to technological progress.

Solomon Fabricant has found that during the 1871–1951 period, technological advance accounted for ninety percent of the rise in output per man-hour (versus ten percent for capital formation).

Benton Mossell found that (during the 1919–55 period) technological change accounted for approximately ninety percent of the rise in output per man-hour.

Edwin Mansfield, in a study of innovation and its effect on the growth of individual companies, found that the innovative companies grew much more rapidly (during a five to ten-year period after the innovation occurred) than other firms in their industries. The average growth rate of the innovators was often twice that of the others.

Zvi Griliches asserts that:

"It is clear by almost any conventional method of measurement that productivity increase has been the most important component of economic growth in the United States in recent decades. The growth in productivity in turn can be divided into two parts: (1) The improvement in efficiency due to the elimination of various disequilibria; and (2) the expansion of the boundaries of knowledge."

Edward Denison predicts that advances in knowledge will be the most significant stimulus for economic growth during the 1960–80 period.

It is apparent to even the most casual observer that advancing technology has drastically transformed the character of man's activity. A century ago, men and animals provided nearly all the musclepower in industry. Machines supplied about one horsepower per production worker. Machines now provide more than ten times that amount of energy. The farm population, in that time period, has decreased from eight in ten to less than one in ten, thanks to increased farm mechanization. And since 1860, the average lifespan has jumped from around forty to around seventy years, owing to medical advances in the prevention and cure of disease and to gains in sanitation and nutrition.

It is clear that the infusion of new technology can speed the rate of economic advance. But the importance of new technology to society cannot be measured solely by its contribution to our gross national product. GNP measures, with limitations, the output of goods and services in the national economic system. But any realistic assessment of economic performance must also consider how that output is distributed, the ability of the system to make the generation of that output personally rewarding, and the environment—or the quality of life—created by the system. GNP does not measure the economic system's performance in terms of giving people what they really want.

Much of the benefit of the infusion of new technology into the economy is not reflected in measures of productivity. For example, if technology permits the making of a better product without a corresponding change in production costs, the result is not reflected in statistics of output—but is a decidedly beneficial action.

One approach to the full realization of the benefits of new technology, it appears, would be to arrange for its effects to be more widely felt—to be diffuse into more industries, more governmental missions, and more regions of the country. In other words, programs to channel new technologies in useful and satisfying directions can have the effect of notably enhancing the rate of economic growth—though the full effect of such programs would likely not be measured by conventional methods.

Denison has shown that differences in levels of formal education attainment create significant differences in productivity. It follows that differences in practical professional knowledge acquired after completion of formal education can have a similar effect. In other words, the scientist, engineer, or businessman who

continued to accumulate new knowledge—via being somehow updated in the latest R&D results relevant to his work—would be more productive than the one who was not. If that logical assumption is true, then investment (public or private) in programs to identify, evaluate, and utilize new technology will pay significant dividends in productivity improvement at the level of the firm or end user of the technology.

Many studies of the contribution of technology to economic growth have concentrated on the economic impact of major inventions and innovations. But the most important contributions to economic growth may be stimulated by widespread adoption of incremental improvements.

John Jewkes has noted that:

"There is no evidence which establishes definitely that technical or economic progress receives greater contributions from the few and rare large advances in knowledge than from the many and frequent smaller improvements. Economically, it might for a period well pay a community to starve its scientific and major technical work and to devote resources to the most thorough and systematic gathering together and exploitation of all the immediate and tiny practical improvements in ways of manufacture and design."

In a recent study by Sumner Myers of the National Planning Association, for the National Science Foundation, the research showed that, in business practice, innovation is more often the result of recognizing and adapting an idea than of inventing a brand new one. Mr. Myers studied 560 innovations by private companies—new products, improved processes, new designs, and the like. He found that half of the 560 innovations were based on information that originated outside the company that brought about the innovation. In a number of cases, the information was seemingly of relatively minor significance—but proved to have important benefit to the companies that used it.

For such reasons, NASA places heavy emphasis on the identification and documentation steps in the transfer process.

The second critical lesson from our experience revolves around the importance of a programmatic approach to technology transfer. The technology transfer process can be viewed as a system.

The system has a number of critical design parameters. These include:

It must be responsive to the varying needs of a wide variety of users. The system must recognize that service is to be provided to individuals—with differing needs. And that any one user's requirements will change with time and task.

It must be capable of providing to the user information of great variety culled from a multiplicity of sources. The system must be designed to provide services—not just abstracts, indexes, books, or periodicals. The focus of the system is to aid people in meeting objectives and solving problems through the use of information.

It must develop from experimentation. The NASA Technology Utilization Program operates in an experimental mode, continually permitting the lessons of experience to guide us toward more effective operational programs. The nature of technology transfer is complex and not yet fully understood. There is still much to be learned—and one of the primary underpinnings of our program is the deliberate experimental search for improved approaches to and methods for the transfer of technology. Technology transfer involves a complex set of problems in attitudes, values, goals, work patterns, orientations, motivation, environment, and other variables.

It must incorporate processing functions that add value to the information. These include screening, evaluation, interpretation, packaging, and synthesis.

It must deliver services that meet the tests of significance, relevance, currency, ease of accessibility, comprehensiveness, intelligibility, and economy.

It must have—as an integral part of its basic design—measures of its utility. At NASA, we have found the best measure of the usefulness of a service to be the marketplace. We've built a market test into all of our dissemination experiments. If the services provided are truly important, the user will begin to bear at least a portion of the cost of making the service available.

There must be a feedback mechanism, permitting user needs to be transmitted to and interpreted for those who supply information into the system.

And there must be, designed into the system, a means of exchanging services among the dissemination mechanisms as well as a means of exchanging information on technology transfer methodology.

Figure 1 is a simplified drawing of the NASA Technology Utilization Program system. It meets all of the tests listed above. Such a programmatic approach is, in this area of activity as in others, far more effective than an approach that employs a collection of unrelated or loosely related projects.

A third critical lesson we have drawn from our experience is the importance of a proper organizational context for the leadership and coordination of a technology transfer mission.

We have indeed been fortunate to be located in an organizational structure, at NASA, which has emphasized technology generation and the application of science from the beginning of the agency. As you know, our Office of Space Sciences and Applications and our Office of Advanced Research and Technology are parallel to the Office of Manned Space Flight in the NASA structure. This emphasizes the importance that NASA leadership has placed on the generation of useful technology and on the early application of NASA capabilities in meeting many national requirements.

When Mr. Webb originated the NASA Technology Utilization Program, he also provided it with the visibility and organizational location necessary to achieve effectiveness. This program has always been headed by an Assistant Administrator and has always been given strong support by the Administrator himself.

The effective transfer of technology cannot be accomplished as a small and separate function of an organization. Absolutely essential is the commitment of the total agency to the function. Those who conceive new technology, those who monitor contracts, those who administer various technology-producing programs, those in charge of other agency functions—all must assume a portion of the responsibility to achieve the optimum additional utilization of new technology.

For that reason, Mr. Webb organized the NASA Office of Technology Utilization as a functional staff office headed by an Assistant Administrator as the functional manager. Within NASA, functional management means "the provision of centralized professional leadership and continuous monitoring, evaluating, and reporting to senior agency officials on agency-wide policies, procedures, and operational practices in a given functional area."

The functional manager is authorized to "establish standards, procedures, and operating guidelines controlling the manner in which the functional effort is conducted throughout the agency, coordinating proposed actions and directives with institutional and installation directors and other functional managers."

I am convinced, Mr. Chairman, that a program to transfer technology effectively cannot be achieved without such commitment on the part of the responsible agency.

An additional lesson from our experience relates to interagency cooperation. For a national program to be effective demands the closest kind of cooperation among the agencies involved—and, in the case of technology transfer, the number of agencies presently or potentially involved is very large.

At NASA, as part of our Technology Utilization Program, we have cooperative arrangements with nine agencies on a continuing basis. These include the Atomic Energy Commission, with whom we carry forward a joint program to disseminate technology emanating from AEC programs to achieve economies of scale and avoid duplication of effort.

With the Department of Defense, we have agreed upon a number of key standards for information handling and information packaging, thus permitting compatibility between the important DOD information resource and our own.

With the Office of State Technical Services in the Commerce Department, we are in almost daily contact, planning, programming, and coordinating with one another so that our two programs reinforce one another to obtain the maximum service to industry for the available resources.

The Clearinghouse for Federal Scientific and Technical Information in the Department of Commerce, of course, sells our publications.

The Government Printing Office handles our printing requirements and the Superintendent of Documents announces and sells our Special Publications.

We have mounted, jointly with the Small Business Administration, an aggressive program to transfer aerospace technology to smaller companies. Together we have conducted several pilot projects and we are currently in the midst of a joint effort that is proving most beneficial. This effort is the joint sponsorship with SBA of a series of conferences to explain the relevance of government generated technology to the needs of industry and to inform industrial management of the availability of technology transfer services from governmental

programs. The series of conferences, co-sponsored by NASA and SBA, is carried forward with the cooperation of the Atomic Energy Commission, Commerce Department Office of State Technical Services, Smithsonian Institution Science Information Exchange, National Referral Center of the Library of Congress, and others.

We have a joint effort with the Social and Rehabilitation Service of the Department of Health, Education, and Welfare under which aerospace technology is being utilized in the missions of that agency, aimed at such objectives as improving prosthetic devices, upgrading retaining and therapy techniques for the physically and mentally handicapped, and in other ways.

With the Office of Law Enforcement Assistance in the Justice Department, we have a joint program that seeks to apply aerospace technology to problems in crime prevention and law enforcement. Services from our Regional Dissemination Centers are made available to research grantees of OLEA.

With the Bureau of Reclamation in the Interior Department, we have just begun a program to aid in that agency's weather modification program. NASA advances in telemetry, sensing and detection, systems design and systems analysis, computer analysis, simulation and modeling, and other technical areas will be brought to the attention of personnel in the Bureau of Reclamation and its contractors whose efforts require advanced technology in those areas.

We are also carrying on dialogues with several other agencies to determine the feasibility and methodology for the application of space technology to their requirements. These agencies include the National Institute for Child Health and Human Development of the Department of Health, Education and Welfare; the Department of Housing and Urban Development; the Bureau of Public Roads; and others.

With the Bureau of Public Roads, we completed one joint project that is having an important effect, in pilot programs, in the reduction of accidents caused by skidding on wet highways. Researchers at the NASA Langley Research Center learned that a principal cause of aircraft skidding on wet runways was the phenomenon of tire hydroplaning. At high speeds on a wet surface, tires are literally lifted from the roadway by the force of the standing water and ride on the layers. Brakes become ineffective and the vehicle is out of control. With the thought that the same phenomenon might apply to automobiles, a small joint investigation was conducted by NASA with the Bureau of Public Roads. It was concluded that we do indeed hydroplane with our cars. NASA and BPR jointly produced a motion picture to alert drivers to causes, dangers, and cures of tire hydroplaning. This film, and the research results underlying it, were broadly disseminated. Among those who acted on these research findings was the California Department of Highway Safety. With the results of that R&D in hand, the California traffic engineers worked with a manufacturer of road-building equipment to build a machine to modify highway surfaces along the lines that the research indicated would reduce hydroplaning. The State of California has modified highways in five locations. The result has been a dramatic reduction in accidents under rain conditions at all five locations. Overall accidents have been reduced by 93.5 percent as a result of this highway modification. Figure 2 shows the accident reduction results in more detail.

A fifth extremely important lesson from our experience relates to the need for especially skilled people to serve as transfer agents.

A message is more likely to gain understanding and response if it fits the pattern of experiences, attitudes, value, and goals of the receiver. True communication is dependent on a number of forces, and the sender of the message can really only control a few of them. He can shape his message, and he can decide when and where to introduce it. He cannot control the environment in which the message is received and in which responses take place, the attitudes and personality state of the receiver, or the receiver's group relationships, standards, objectives, and priorities.

The problem has been eloquently described by Robert A. Solo:

"Rendering articulate the complex and the new is a most difficult task; difficult even when those who would speak together share a common language. And sharing language is far less the usual case than is ordinarily supposed. Such a language is no mere matter of grammar, syntax, and standardized vocabulary. It is also in the habits of thought, in the individual's points of reference, in his philosophy, his values, and his experience, in the form of establishing credibility, and in his manner of ordering the evidence. We speak

at each other but we hardly ever converse. And if the one speaks openly and clearly of the significantly new, the other must not merely listen. He must have the capacity to comprehend and assimilate. He must be able to understand. There are two sides always, the speaking and the listening, the giving and the receiving; both require effort and skill. The communication of significantly new insights, invention, thought—even between two individuals face to face—is difficult and rare. But how infinitely more difficult when the communication of invention or discovery is not from man to man but from group to group, from company organization to company organization, from industry to industry, from sector to sector, from nation to nation, from social culture to social culture. Language, interest, outlook, distance, and time—sheath upon sheath—separate the thought and perception of one from the perception and thought of another."[1]

The point is: Any means of channeling new technologies in promising directions eventually boils down to communicating information on new technology from its point of origin to its point of potential use. Richard Rosenbloom, who has studied the technology transfer process notes:

The transfer of technology—whether it be from person to person, firm to firm, industry to industry, or government to private enterprise—depends primarily on the exchange of information rather than upon the exchange of things. In the long run, therefore, the fullest utilization of the technological byproducts of military and space development will flow from a healthy and effective technical information system. This system is not a single monolithic entity, but rather is an amalgam of many loosely interlocking institutions and procedures, serving many publics, concentrating on various aims. Within it, information is exchanged not only by the storage and dissemination of documents, but also by many interactions, formal and informal, between people.

Thus the mechanisms devised to perform the function will center on the gathering, evaluation, packaging, analysis, interpretation, categorizing, extrapolation, assembly, association, handling, and communication of information.

To perform those tasks well, we must learn considerably more about both man and machine. We must develop mechanical and electronic tools, primarily computer systems, to permit us to speed the routine portions of the task. And we must find, educate, and motivate more people to perform the more imaginative portions of the work.

Some of the experience and knowledge necessary to build these man-machine systems has already been achieved and more is being accumulated from programs now underway.

Sixth, our experience has indicated that great importance must be placed on employing the traditional "trusted source" institutions to provide technology transfer services to industry.

Industrial problems, objectives, and long range plans are, by necessity, proprietary. To apply relevant new technology to those problems, objectives, and plans demands that some knowledge of them be provided to the person or organization providing the service.

Equally important, the source of the information must have a demonstrated high credibility rating if industry is to rely on the information for decision-making.

That is why we at NASA have relied so heavily on the service-oriented universities and not-for-profit research institutes to provide the bridge between the information base and the information user.

This has been a difficult task for the organizations involved, but they have made good progress in the face of many obstacles. As an example, permit me to report on the progress of the Regional Dissemination Centers sponsored by NASA.

New technology occurs in bits and pieces, but it must be used in packaging.

To solve a given probem in one context may require the pulling together of knowledge developed for a dozen other purposes, adaptation of that knowledge to the specific situation, and often the creation of new knowledge to round out the package so it can be applied.

The delivery of tailored packages of knowledge in response to user needs is the aim of the experimental Regional Dissemination Centers established by

[1] Solo, Robert A., "Studies in the Anatomy of Economic Progress," a working paper.

NASA. Nine Centers, each one different, now exist. They range in age from five months to 54 months.

They are obligated to become self-supporting in five years or less on the basis of industrial fees for services rendered.

They are located at universities or not-for-profit research institutes.

All are oriented toward fulfilling the service role of their institutions, as well as their research and teaching roles.

All are supplied by NASA with the information collected by the Scientific and Technical Information Division and with that division's expertise in information retrieval.

The Regional Dissemination Center not only transfers technology; its broader purpose is to educate industrial management in the use of externally generated knowledge. That is done largely by demonstration of the value of actively seeking for one's own use the results of R&D performed elsewhere. The RDC performs this function via a range of services—including assistance in problem and objective definition, retrospective literature searching, provision of current awareness services to keep technical people updated in their fields of interest, and more recently, management techniques services to keep management people updated in their fields of interest, calling client companies' attention to product developments or process improvements, and provision of information on management sciences and management techniques emanating from large federal programs such as those of NASA. In such ways, the Regional Dissemination Centers add value to the basic information. The client companies pay for this added value rather than simply for the information itself. The various services offered by the RDC's have proved useful to companies in:

Product Innovation.
Process Improvement.
Setting of R&D Priorities.
Prevention of duplicative research expenditures.
Continuing education of professional personnel.
Improvement of managerial practices and in other ways.

In the early days of the RCDs, many observers felt they would prove useful only to giant companies with large technical staffs. Recent experience, however, has indicated that smaller companies too can effectively use these services. Small company membership has grown to 45 percent of the total membership.

These experiments appear to be proving successful. The number of fee paying member companies has reached 286, up from 145 a year ago.

Of the total, 105 companies are now paying fees for their second or third or fourth year, indicating the services have been useful.

And of those who have been members for more than one year, 22 percent have renewed their memberships for higher rates of service than in the first year of membership.

Progress toward self support is indicated by the experience of the first computer-based RDC, Aerospace Research Application Center (ARAC), at Indiana University. It will be almost completely self supporting by the end of 1967. Progress of most other centers is commensurate.

Each Regional Dissemination Center (RDC) has numerous unique elements. Each, for example, has a different institutional base, and we are analyzing this variable as a factor in dissemination effectiveness.

Each also employs a somewhat different kind of coupling mechanism between its information storehouse and the client company. The many variables involved here are being analyzed to learn more about the transfer process.

And each RDC has undertaken a different set of special pilot projects aimed at getting an even larger return on the investment in federal research and development by finding a larger number of effective markets for the R&D results.

Seventh, agencies charged with the responsibility for technology transfer must assume, our experience indicates, an entrepreneurial attitude. They must continually seek new and better ways to enlarge the return on the national investment in research and development by encouraging additional uses for the results of that R&D.

One such example relates to a program we started about a year ago to enlarge the public return on the NASA investment in computer software. Many of the computer programs developed for NASA mission uses have potential additional utility—in industry, education, medicine, and elsewhere.

To make these programs available, NASA has contracted with the University of Georgia to evaluate the utility of the programs outside the aerospace community and then to sell the useful programs to industry and others for the cost of reproduction and distribution. Thus, a computer program that may have cost $200,000 to develop can be obtained by a company for as little as $75.

Another example is our establishment of an experimental program to transfer aerospace technology to the fields of biology and medicine. Three Biomedical Application Teams have been formed at three independent research institutes. These small teams establish interinstitutional relationships with groups conducting R&D in biology and medicine—at universities, clinics, and research hospitals. The multidisciplinary teams assist the researchers in identifying and defining the barriers impeding the progress of their research.

These barriers—or problems—are then described or specified in non-disciplinary, functional, terms in a "problem Abstract." (This activity is largely coordinated by George Washington University under contract to NASA.)

More than 100 important medical problems have already been identified by the Biomedical Application Teams as possibly being capable of solution through aerospace knowledge.

The Problem Abstract forms the basis for a computerized search of the NASA information store to seek out relevant information—especially engineering and physical science know-how that would be relevant to solving these life science problems. The Problem Abstracts are also circulated to Technology Utilization Officers at NASA field installations who seek ideas, concepts, and approaches toward the solution of those problems from NASA scientists and engineers.

Results have already been achieved. Let me cite three examples:

In pediatric respirator studies, subjects have been forced to breathe through a rubber mouthpiece. It is uncomfortable, but more important, the mouthpiece often slips and exhaled air is lost, thus damaging the accuracy of the measurements. A solution to the problem was found in the Gemini helmet which provides a respiratory environment for an astronaut.

The basic concept of the helmet has been adapted for pediatric use at a midwestern research hospital. A suction pump in the breath analyzer provides negative pressure in the helmet, preventing any escape of exhaled air. And the elimination of the mouthpiece permits the patient to breath normally. Exhaled air is analyzed to determine its composition; oxygen consumption and other data is read out graphically. The data gathered in this way will be used to establish criteria for desirable exercise levels for both normal children and for children with certain respiratory ailments.

To detect micrometeorites, a momentum transductor was developed at Ames Research Center. It's based on a crystal that twists slightly on impact and sets up an electrical signal. It will detect a grain of sand dropped from less than an inch. The principles of this device have formed the basis for a new kind of diagnostic tool that will accurately measure subtle postural reflexes. This new tool, a kind of muscle accelerometer, can be taped to a patient's finger to record lateral movement or to the fingertip to measure vertical movement. This new diagnostic tool permits gathering of data more accurately than ever before. (High speed photography has been the primary means.) The device is being evaluated for possible routine clinical use in the early detection of neurological ailments, including Parkinson's disease.

For several years, Jet Propulsion Laboratory has used computers to enhance the quality of Moon and Mars pictures from spacecraft. Surveyor I, for example, radioed to Earth more than 11,000 close-up pictures of the Moon. They are sharp but have certain limitations in fidelity.

An investigation has begun to apply this enhancement technique to clarifying medical X-rays. By increasing the contrast of certain details, the enhancement process emphasizes features or areas of a picture which provide critical information. Figure 3 shows X-rays of a human skull. We want to bring out the blood vessels. With a digital filter, the computer recovers them, although at a cost of some distortion in the remainder of the picture. The enhancement process, of course, adds nothing that was not originally photographed, but it brings out details which are otherwise not visible.

Eighth, we have also learned the importance of providing screened and interpreted information, wherever practical. The ease of using it encourages its use.

An example of this approach is the NASA Technology Survey. The nature of NASA missions is such that success has demanded, in some cases, that the agency move forward a whole area of technology—making major contributions on a broad front or quantum jumps in the state of a single art. Where that takes place, the Technology Utilization Division seeks to consolidate those gains for the use of those outside of aerospace. One approach employed is the Technology Survey. Note authorities in a field are retained under contract to survey the newly advanced state of the art and write "guidebooks" so others may learn about the latest advances—which are highlighted—and then led by the author to sources of additional information. Another approach is via a conference, such as one held at Lewis Research Center for the petroleum industry—and Proceedings are published.

A ninth lesson from our experience relates to the importance deliberately designing mechanisms to couple Research and Development.

Figure 4 is an attempt to show the technology transfer process graphically. Research is originally conducted within a given subdiscipline. Its utility in that area is assumed. The research is often also motivated by a development need and the results of the research are immediately transmitted to those performing that development, indicated by the diagonal line. The research results are also communicated . . . by professional journal, professional meeting, or other traditional means . . . to other researchers in the same subdisciplinary division of activity, indicated by the circular flow line.

But the research results may have applicability in other areas of research and must somehow become available to . . . or even called to the attention of researchers in those areas, as indicated by the horizontal line.

The research results, almost certainly, will have applicability to development projects other than the specific one that motivated the need for the research. In fact, the most important benefits of the research often accrue from use of the research results in development projects other than the specific one for which the work was done. Thus we, in the NASA Technology Utilization Program, devote a large part of our effort to the communication represented by the vertical tree.

Development, of course, feeds back into research . . . sometimes in disciplines far removed from those drawn upon for the development effort. We devote some of our attention to this cross-disciplinary feedback type of technology transfer.

And then we come to the most common form of technology transfer . . . and the one to which we give the most emphasis in our program. This is the use of the results of one development effort in other engineering or development efforts, the D-to-D movements on the diagram.

A great deal of this latter kind of technology transfer occurs naturally. It occurs when a machine tool salesman sells a numerically controlled milling machine to aid in the production of a new product. It occurs when a design engineer uses handbook data. It occurs when a laboratory technician draws upon his experience in an earlier project to rig up a special device or instrument. It occurs when the manufacturing engineer in a farm equipment plant draws upon the automotive transfer line concept to improve the efficiency of component flow in his plant. And it routinely occurs in management, as the manager draws upon his experience . . . or that of someone else . . . in an analogous situation to reach a decision.

But in nearly all of these cases . . . and this is a critical point . . . the user of knowledge draws upon more than one source to get the package of knowledge he needs to meet his objectives.

New knowledge occurs in bits and pieces . . . but it must be used in packages. To solve a problem in one context often requires the pulling together of bits and pieces of knowledge from many other sources, the adaptation of some of those pieces to fit the specific environment or parameters of the immediate problem, and sometimes the generation of new knowledge to round out the package so it can be applied.

Let me now take just a few minutes to give a progress report on the NASA Technology Utilization Program.

You will recall that our four primary purposes are:

(1) To increase the return on the national investment in aerospace research and development by encouraging additional uses of the knowledge gained in those programs.

(2) To shorten the time gap between the discovery of new knowledge and its effective use in the marketplace.

(3) To aid the movement of new knowledge across industry, disciplinary, and regional boundaries.

(4) To contribute to the knowledge of better means of transferring technology from its points of origin to its point of potential use.

I would like first to mention the progress we have made in identifying and documenting new technology emanating from NASA programs and evaluating its significance for application outside the aerospace community.

The number of inventions, innovations, improvements, and discoveries identified during calendar year 1966 was nearly triple the number identified during calendar year 1965. And our present annual rate is 30 percent above the 1966 level. Substantial improvement was made in identification of new technology originating at NASA contractors. The percentage mix of new technology by place of origin is beginning to approximate the same relative proportions as the allocation of NASA research and development expenditures.

This results in part from improved definition of contractor performance standards, increased efforts to educate and motivate contractor personnel to NASA technology utilization purposes and requirements, guidance to contractors on the development of internal systems and procedures to identify new technology resulting from their work under NASA contracts, and improved definition of the scope of useful new technology and the necessary depth of its documentation for effective transfer.

The innovations, inventions, improvements, and discoveries identified in those efforts are evaluated at two levels to determine their novelty and commercial significance. They are evaluated at NASA field installations and, as appropriate, by independent research institutes under contract to NASA.

Those items which appear to have commercial utility are brought to the attention of business and industry in several ways.

The most familiar medium for dissemination is the NASA Tech Brief. Figure 5 illustrates the Tech Brief. This announcement briefly describes the innovation or invention and explains the concepts and principles underlying the innovation. Ideas presented in this way stimulate thought and the explanation of the underlying concepts and principles permits the reader of the Tech Brief in an unrelated industry to proceed from those principles to the design of an analog of the hardware developed for aerospace use and mentioned in the Tech Brief. The businessman who is interested in any innovations so announced can obtain additional information—including test data, drawings, specifications, and the like—by writing to the NASA Technology Utilization Officer at the address shown on the Tech Brief.

During calendar year 1966, NASA issued 714 Tech Briefs, up from 378 in calendar year 1965. We expect to issue around 800 Tech Briefs in calendar year 1967. And we will announce several hundred more innovations in the form of compilations.

Discoveries of great magnitude, those that lead to the creation of whole new industries for example, generally have sufficient inherent force to bring about their own exploitation. But the incremental advances that individually seem of minor importance, but in combination underpin our industrial might, are less easily brought to the attention of the many who can benefit from them. The Tech Brief aims at that goal.

Innovations of special significance or complexity are announced via Technology Utilization Reports, more extensive descriptions than given in a Tech Brief. Sample titles of Technology Utilization Reports issued in the last year include *Commercial Potential of Semipermeable Membranes, Some New Metal and Metal/Ceramic Composites*, and *Tungsten Powder Metallurgy*.

Technology Surveys are being issued at a more rapid rate. To date, 15 Technology Surveys have been published and twenty more are in preparation. Recent titles include *Solid Lubricants; Cardiovascular Monitoring; Adhesives, Sealants, and Gaskets;* and *Selected Advances in Metals Joining*. Among the topics of surveys in progress are *High Velocity Metal Forming; Chemical Analysis*

Instrumentation; Improvements in Valve Technology; Advances in Foamed Materials; New Structural Design Concepts; Fluid Film Lubrication; Liquid Level Measurements; Contamination Control; Explosives and Explosive Devices; Acoustics; Thermocouples; and *Visual Information Display Systems.*

Technology Utilization publications are sold to the public by the Government Printing Office and the Commerce Department Clearing House for Federal Scientific and Technical Information.

During calendar year 1966, Technology Utilization publications generated more than 8,000 inquiries to NASA for additional information about specific inventions, innovations, or discoveries or about areas of new technology. At present, inquiries are coming in at an annual rate of about 10,000.

Earlier in this testimony I described the progress being made by the experimental Regional Dissemination Centers, the Biomedical Application Teams, the computer program dissemination project, and other elements of the NASA Technology Utilization Program.

As a result of these activities, we are aware of hundreds of cases of the industrial use of technology disseminated via the NASA program. An Appendix to this testimony, submitted for the record of these hearings, lists a number of examples.

Substantial progress has been made—but even more remains to be done.

I submit that bringing about such additional returns on our national investment in research and development is one of the most economically productive and intellectually challenging activities in the world today.

It is especially important during this time of rapid technological change—because the sheer volume of useful new ideas, the sheer size of the information explosion, will lead to fragmented and ineffective science and technology unless the right information in the right form can be made available to the right man at the right time.

To turn government generated technology into a national asset with many uses should be one of our major goals. It should be the critical challenge to those of us in the communications business. If we do, our national rate of growth will rise and the quality of our lives will be improved. If we don't, technology might turn out to be a liability rather than an asset.

To turn it to a useful asset will require the acceptance of responsibility by three large groups.

The creator of new knowledge must accept a part of the responsibility for communicating that new knowledge to others who can use it. All those concerned with research and development must accept responsibility for documenting and communicating their results in the same spirit that they accept responsibility for the R&D itself—for the two functions are inseparable. Doing less will obviously lead to fragmented and ineffective science and technology.

The applier of new knowledge must begin to aggressively seek relevant information from outside his discipline, industry, or region.

A mission-oriented government agency, such as NASA, can make major contributions by conducting experiments to learn how best to encourage the broad and effective use of new knowledge generated at public expense—to obtain the optimum return on that investment. To do less would be to fulfill only partially the public responsibility to make the wisest allocation of resources to serve the long term national interest.

There are many steps in the technology transfer process to which additional attention must be devoted.

We must design better switching mechanisms to get the man with a need together with the knowhow wherever it might exist.

We must give more thought to how we package and present information.

We must be more critical of what we publish to avoid polluting the information stream with garbage, rehashed information with no value added, results of shoddy research projects, and sheer puffery.

We must do a better job of learning the real needs of our audiences and gearing our information gathering activities accordingly.

We must do a far better job of analyzing document content to write abstracts that truly reflect content.

We must learn how to index for a multiplicity of users without misleading the searcher.

We must learn how to tie disparate banks of information together in a meaningful way and begin to create an efficient and effective national network of systems.

We must begin to look upon documents as only our raw material, not the finished product and to tailor services that provide answers to the users, not just abstracts or piles of documents.

We must become better interpreters of information for our managerial, scientific, and engineering audiences, giving some emphasis to the "why" and "what it means," rather than simply concentrating on the "what and how."

We must expend more effort to bring to the attention of a man in one discipline or industry the relevant information generated in many totally different contexts.

And, certainly, we need to do meaningful research in how to improve the efficiency of the process by which ideas become accepted or rejected within organizations.

We also need to critically examine—and adopt where practical—new hardware technology that improves the speed and effectiveness of the communications process. As one example, consider our RECON experiment at NASA. RECON—for remote console—is a very fast and flexible method of do-it-yourself information retrieval. It enables a user to conduct a real-time electronic dialogue with a time-shared, remotely located computer in his search for information. The user needs no special skill, no special training. He sits at a small console and uses a typewriter keyboard to identify himself, to get the computer to tell him what to do if he doesn't already know, and then to pose his questions. A variety of search strategies is possible, and it takes only seconds to compare the probable productivity of different approaches. The computer gives its instructions and answers in plain English, displayed on a cathode-ray screen above the console. When the user of RECON sees citations of documents he wants, he presses a button which automatically notifies his local library of his request, and the documents can be on his desk in a matter of hours.

In summary it should be noted that in the space program—and in many other Federal programs—we have learned to marry the disciplines of science, engineering and management into one team that tackles problems of any size or complexity. In the future this nation will marshal the same forces to conquer other large problems and in much the same way.

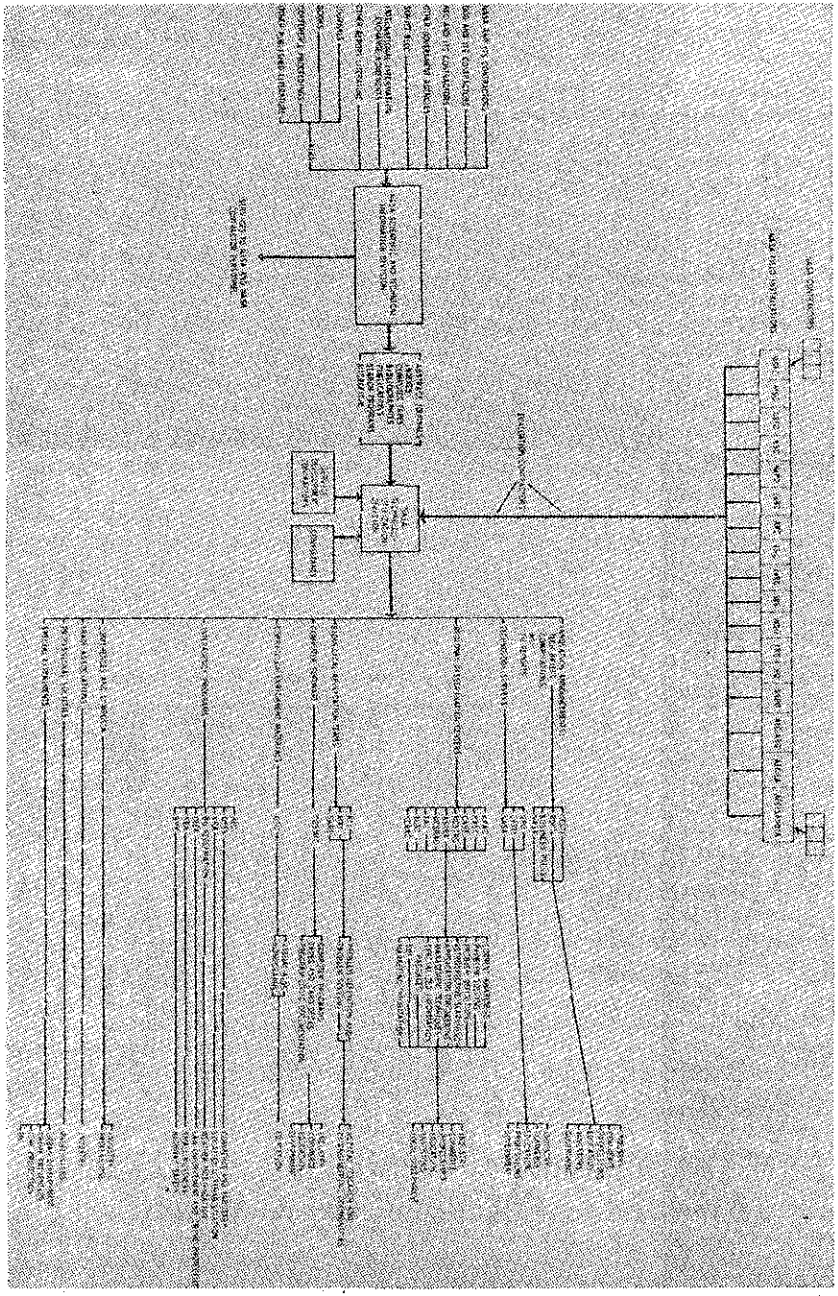
But *solutions* to many currently pressing problems of concern to government and industry already exist in the form of the new knowledge emanating from the large federal research and development programs. This year alone the federal investment in research and development will approximate $15 billion, and we have tried to demonstrate that the second and third order effects of that investment constitute a substantial bonus return which, in the long run, may be at least as important as the primary effects.

However, these bonus returns do not accrue automatically. We have pointed out the necessary ingredients of an effective technology transfer program which include: a systematic identification and documentation, a programmatic approach based on carefully constructed experiments, a high degree of organizational visibility and total agency support, interagency cooperation and communication, and effective communications mechanisms involving trusted source institutions with entrepreneurial attitudes.

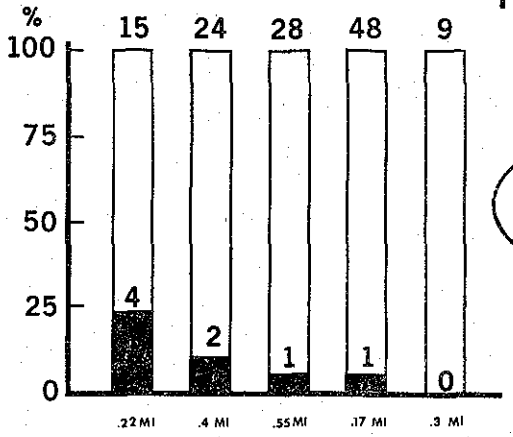
The efforts to date represent a modest investment and have a history of only six years. The technology transfer process is complex and faces a significant initial resistance. Nevertheless, these difficulties are being overcome daily and our attentive and enthusiastic user audience is growing rapidly.

The conclusion, therefore, which we convey with a note of urgency is a call for the prompt consideration of mechanisms which would provide for the widest practicable and appropriate dissemination of knowledge emanating from federal research and development activities. This in turn would give much greater visibility to this valuable national resource and would virtually assure its effective and profitable utilization.

LIST OF FIGURES



HIGHWAY MODIFICATION EXPERIMENT
STATE OF CALIFORNIA --- INTERIM RESULTS



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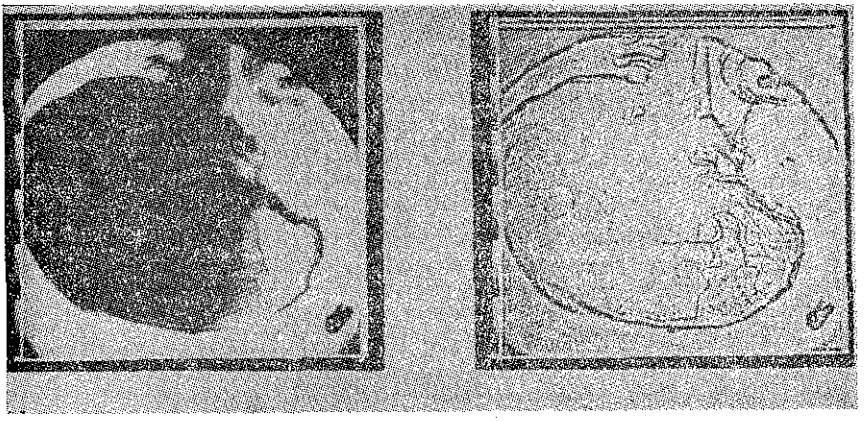
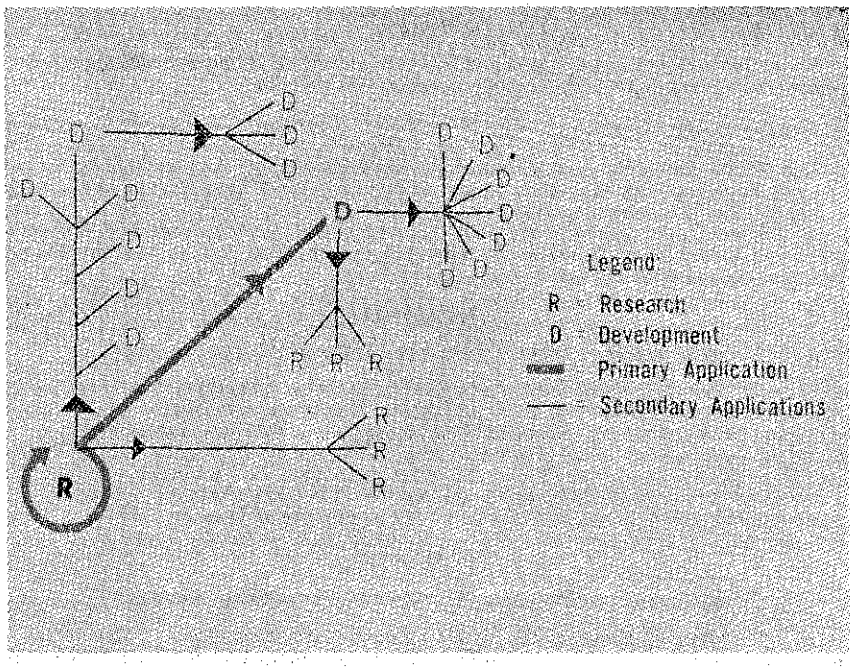
93.55%
OVERALL
REDUCTION

8 AFTER

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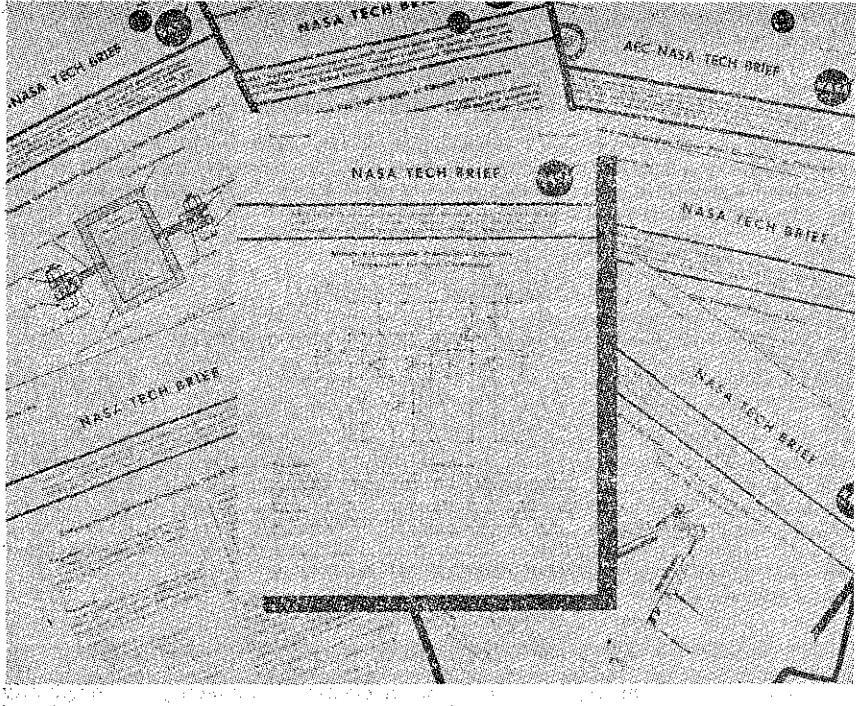
Primary Application
Secondary Applications


NASA TECH BRIEF
ARC NASA TECH BRIEF

APPENDIX

Following are typical examples of industrial use of aerospace technology disseminated via the NASA Technology Utilization Program:

FIRM MARKETS BEING COATED WITH NEW DRY LUBRICANT USED BY NASA

The NASA Lewis Research Center developed a ceramic-bonded dry lubricant for use on a rotating seal of a pump for liquid flouride propellants under high temperatures in vacuum. Lewis developed the necessary process to bind the film onto the metal. An Eastern company learned of the development and obtained technical information from Lewis Research Center. The firm is now marketing bearings coated with the lubricant.

(LET–6601)

NASA TESTING UNIT SOLVES PROBLEM FOR PLASTICSMAKER

A Pennsylvania producer of plastics has adopted an innovation reported in NASA Tech Brief 65–10173. The innovation, developed to meet a measurement requirement at Goddard Space Flight Center, can measure the strength of a bond between a plastic material and any other material. A spokesman for the company that is using the device reported that there has long been a need for a device of this type and recommended that the American Society for Testing and Materials consider the unit as the standard device for such tests.

(GDT–6605)

TECH BRIEF SAVES COMPANY "SEVERAL THOUSAND DOLLARS"

The president of a consulting firm in South Carolina reports: "The contents of NASA Tech Brief 65–10190, coupled with experimental data which we were in the process of obtaining for a client permitted us to arrive more quickly at a recommendation for the client to abandon a project under investigation. This resulted in a savings to the client of several thousand dollars . . ." The Tech Brief described studies of bismuth trioxide-tellurium dioxide glasses with improved infrared transmission characteristics, based on work performed at the NASA Marshall Space Flight Center.

(MFT–6605, MD–6601)

GREETING CARD COMPANY MAKES QUALITY IMPROVEMENT

A Regional Dissemination Center called to the attention of a greeting card manufacturer a locking device developed for NASA in a program at the NASA Marshall Space Flight Center and announced in NASA Tech Brief 64–10249. The cardmaker built five units based on the NASA design for use on a camera exposure mechanism, resulting in better exposure control for improved quality as well as greater convenience.

(MR–6604, MFT–6604)

FOUR COMPANIES ARE USING NASA-DESIGNED PEEL TESTER

The NASA Goddard Space Flight Center developed a device to accurately measure peel strength of composite materials. The innovation was reported in Tech Brief 65–10173. A major metal producer, having just entered the composite materials business, has employed the Goddard concepts to modify and improve its own measurement apparatus. A large Eastern company built a unit based on the Goddard design and is employing it to test adhesive bonds. A large lumber company in Washington has built a testing device based on the Goddard information for use in testing the peel strength of aluminum-plywood laminates. A pen and pencil manufacturer is using it to test the bond between metal inner shells and plastic outer shells of its pens.

(GDT–6607, MR–6621)

ELECTRONICS FIRM ADDS SNAP-ON RACK PANEL TO ITS PRODUCT LINE

A Midwestern company is marketing an electronic snap-on panel originally developed at the NASA Goddard Space Flight Center and reported in Tech Brief

64–10121. The significant feature of the panel is that it can be simply fastened by lining up guide pins with matching mounting holes on the rack frame and applying light pressure to engage the snap fasteners. Commercial production of the panel was started late last summer.

(GDT–6602)

FIRM APPLIES NASA LUBRICANT, NOW CONSIDERS MARKETING IT

An Illinois firm experimentally applied a solid lubricant, developed under contract to NASA, in one of its metal forming operations. The firm is now evaluating the results of that experiment with an eye toward manufacturing and marketing the lubricant. The formulation is one of five developed by a Midwestern organization under contract to the Marshall Space Flight Center and subsequently reported in NASA Tech Brief 63–10453.

(MFT–6604, MR–6614)

COMPANY BEGINS MARKETING CRYOGENIC FLUID LINE CONNECTORS

A California company has begun manufacturing and test marketing a high vacuum, cryogenic, fluid line connector developed at Goddard Space Flight Center and reported in NASA Tech Brief B64–10327. The transfer was successfully made when the Technology Utilization Officer at Goddard provided the company with additional significant information.

(GDT–6603)

NASA THERMOCOUPLE FOUND USEFUL IN CRYOSURGERY

A doctor in a New York hospital is now using a commercially available microthermocouple probe in cryosurgery for patients with dystonia, Parkinson's Disease, and other diseases causing abnormal muscular motion. Two doctors in a Boston hospital are using the same instrument in surgery to repair lesions of the eye by "welding" tissue at cryogenic temperatures. The microthermocouple probe was originally developed under contract to the NASA Lewis Research Center.

(LET–6603, MD–6603)

LAB BUILDS DEVICE INCORPORATING THREE NASA ELECTRONIC CIRCUITS

The New York laboratory of a large firm has incorporated three NASA-developed electronic circuits in an ultrasonic testing system it designed for its own use. All three circuits were developed at the Goddard Space Flight Center and reported in NASA Tech Briefs B63–10554, B63–10603, and B64–10007.

(GDT–6604)

APPLIANCE PRODUCER PLANS TO USE THERMISTOR PROTECTION SYSTEM

An appliance company has announced plans to employ in its appliance controls a thermistor protection system developed at the NASA Goddard Space Flight Center and reported in NASA Tech Brief B64–10281. The firm has obtained further information from the Goddard Technology Utilization Officer. The innovation has the advantage of not requiring resetting after an overload while providing for the necessary current limiting function.

(GDT–6606)

ELECTRONICS FIRM TEST MARKETS LANGLEY-DEVELOPED CONTAINER

A company in Southern California is test marketing flame sprayed evaporation boats (containers) developed at NASA Langley Research Center and reported in NASA Tech Brief 65–10063. At last report, three months ago, the company had several of the units in the hands of customers for evaluation.

(LAT–6604)

VENTED PISTON SEAL AIDS PETROLEUM FIRM

An Oklahoma Petroleum company wanted to avoid a time consuming sample collection and analysis process by using on-line refractometers in process control. However, implementation of the idea was held back for want of a proper dynamic seal. Then an employee of the firm noted a reference in an engineering magazine to NASA Tech Brief 63–10141, describing a vented piston seal developed at Jet Propulsion Laboratory for NASA. The company obtained additional information from JPL, modified the seal slightly, incorporated it into the system, and reports that "the device has been of great value."

(NAT–6602)

DEVICE DESIGNED AT GODDARD USED IN TRAFFIC CONTROL

A small New Jersey company has incorporated the design for a reversible ring counter developed at the Goddard Space Flight Center in an experimental traffic control computer. The device was reported in NASA Tech Brief 64–10144 and additional information was provided by the Goddard Technology Utilization Officer.

(GDT–6608)

FIRM INCORPORATES NASA SWITCH IN SPECIAL REFRIGERATOR LINE

A northeastern company has incorporated in its special refrigerator (cools to 4 degrees Kelvin) an automatic thermal switch developed at Jet Propulsion Laboratory and reported in NASA Tech Brief 65–10068. Upon seeing the Tech Brief, the firm requested and obtained from NASA a non-exclusive, royalty-free license to practice the invention.

(NAT–6603)

NEW PRODUCTS, PROCESSES AND MATERIALS RESULT FROM EFFECTIVE USE OF RDC

The following is a direct quote from a letter sent to an RDC by the president of a member company: "New products, processes, and materials have been made available by utilizing different techniques than what were employed here before on the production of some of our products, especially solid state materials. Also, your service has shortened our research and development efforts since all of the data and necessary abstracts are at our fingertips and when documents are required we have been obtaining them promptly from your system and this has reduced our literature search time to a minimum. It has caused the purchase of new equipment as well as the constructing of new equipment. Several new furnances are currently under construction because of your service. We have hired at least four employees and have eliminated certain production steps. As far as maintenance, health, safety, or improved quality of products—this is not known as yet. Many of the documents forwarded to us have been utilized for new measurement techniques. The dollar estimate as to benefits we have derived—for certain, it has increased our volume by at least $95,000 which we can directly attribute to your system by enabling us to come out with products never produced before. Also, this should drastically increase in the future."

(KR–6601)

NASA TECHNIQUE FOR PILOT USE NOW EMPLOYED IN BIOMEDICINE

At the NASA Flight Research Center, a new technique for applying electrocardiographic electrodes to test pilots was developed. A liquified, conductive, mixture is sprayed over the ends of lead wires onto the patient's chest. The coating dries quickly, is thin, is flexible, is not uncomfortable, and can be easily removed—but will keep the electrodes in intimate contact with the skin during exercises causing perspiration. Two clinical groups are now using the technique to gather data on patients and medical test subjects as a result of having been introduced to the technique by a NASA-sponsored Biomedical Application Team.

(FRT–6601, MB–6602)

MORE THAN DOZEN COMPANIES USE NASA COMPUTER PROGRAM

A computer program entitled FLOTRAN was developed under contract to the NASA Marshall Space Flight Center to automatically produce flow charts from assorted input statements. The development of the program was announced in NASA Tech Brief 66–10062 and copies of the program were made available, at the cost of reproduction and distribution, to interested inquirers. More than 300 inquiries were received; more than two dozen companies purchased copies of the program; at least a dozen companies have found it useful. In one case, for example, a company says the availability of this computer program saved three man-months of effort. Another company found it "offers significant savings both as a documentation aid and in locating deficiencies."

(CO–6601, MFT–6601)

MISSOURI COMPANY ADOPTS TWO INNOVATIONS FROM TECH BRIEFS

A firm in Springfield, Missouri, has developed two items of equipment for its production and laboratory operations based on two NASA innovations announced in Tech Brief 63–10376 and Tech Brief 63–10338. The one innovation, a special clamp for precise weld alignment, was originally developed at the NASA Marshall Space Flight Center. The other innovation, an optical measurement technique to determine torque at high rotational speeds, resulted from a NASA program at NASA Lewis Research Center.

(MR–6603, MFT–6603, LET–6604)

COMPANY ADDS PRODUCT TO FASTENER LINE

A Missouri company has redesigned the lock nut concept announced in NASA Tech Brief 65–10135 for addition to its existing product line of fasteners. A company official reports that the Tech Brief provided the stimulus needed by the company's design group to add this product which will meet certain known customer requirements. The lock nut concept was originally developed under contract to the NASA Manned Spacecraft Center.

(MR–6601, MHT–6602)

NASA TECHNIQUES SHOW FOREMAN HOW TO SOLVE WELDING PROBLEM

The plant foreman at a small company in Missouri was faced with a problem of welding resistance, welding a contact on a spring where differential thickness posed a severe problem. He contacted a Regional Dissemination Center which provided him information contained in NASA SP–5002, "Reliable Electrical Connections," and NASA SP–5011, "Welding for Electronic Assemblies." This information showed the foreman how to solve the problem. The foreman also reports he now keeps copies of both publications on hand and has referred to them on several other occasions as problems are encountered.

(MR–6602)

NASA STRUCTURAL INNOVATION LENDS SAFETY AND EASE TO CONSTRUCTION JOB

A Midwestern company specializing in electrical and hydraulic contract construction credits a NASA innovation with making dam construction both safer and easier. The innovation is a self-balancing beam, developed in a program at the NASA Marshall Space Flight Center, and announced in NASA Tech Brief 63–10571.

(MR–6605, MFT–6605)

CONFERENCE PAPER PERMITS EXPANSION JOINT REDESIGN

A firm in St. Louis queried a Regional Dissemination Center for information on bellows, gimbals, and clamps for use in redesigning a line of heat exchangers. Among the information the RDC provided was a paper delivered at a Marshall

Space Flight Center "Technology Status and Trends Symposium." Information in the paper was used by the company to redesign an expansion joint for the heat exchangers.

(MP–6606, MFT–6602)

FIRM REQUESTS LICENSE, PLANS PRODUCT ADDITION

A routine mailing of information to client by one Regional Dissemination Center has led to a new product for the firm. One such mailing included NASA Tech Brief 65–10117, announcing NASA development, at the NASA Lewis Research Center, of an invention, "double gloves for reduction of contamination in a dry box atmosphere." The company has applied for a non-exclusive, royalty-free, license and plans to market the invention.

(MR–6607, LET–6606)

NASA TECH SURVEY HELPS MEET NEEDS OF COATINGS FIRM

While carrying out a program to develop ceramic coatings for aluminum, a Kansas City company obtained a copy of a NASA Tech Survey, "NASA Contributions to the Technology of Inorganic Coatings," from a Regional Dissemination Center. Information in the publication led the firm into a significant new approach to development of noncombustible binders for its coatings.

(MR–6608, TS–6601)

NASA PAINT SAVES COMPANY SEVERAL THOUSAND DOLLARS YEARLY

A manufacturer of gypsum products (plaster, wallboard, etc.) had difficulty because its uncoated calcining kettles contaminated the gypsum products with iron specks. The company therefore sought a protective coating that would be abrasion resistant, not decompose in a moist oxidizing atmosphere, operate at temperatures up to 2000 degrees F, withstand acid and other highly corrosive materials, and permit easy release of the gypsum products being processed. After some searching, the company was told by a Regional Dissemination about a paint developed at Goddard Space Flight Center and described in NASA Tech Brief 64–10026 and NASA Tech Brief 65–10156. Additional information was provided by the Technology Utilization Officer at Goddard Space Flight Center and by the Regional Dissemination Center. The company developed its own procedures for preparation and application of the paint, then conducted tests and found the paint was preferable as a coating in this application of the paint, then conducted tests and found the paint was preferable as a coating in this application to the use of high temperature resistant plastics, metallizing with stainless steel, and other commercially available coatings. The company began routine use of the NASA-developed coating. After six months, kettles coated with the paint still showed no apparent deterioration. It is estimated that several thousand dollars are saved yearly by use of the coating. The firm now plans to test the paint on the internal surface of a tube mill where the coating will be subject to sulfuric acid at 1300 degrees F. Other potential applications are under consideration.

(MR–6609, GDT–6601)

REFRIGERATION SERVICE FIRM GETS TUBE BENDING TIP

A small refrigeration service company had difficulty bending tubing at sharp angles without damage or rupture. A Regional Dissemination Center provided the answer by bringing to the company's attention a method used at Ames Research Center which saved the firm labor and material.

(MR–6610, ART–6602)

PAPER COMPANY ADDS NASA SAFETY FEATURE

A paper company needed a specialized shock absorber for its printing presses as a safety feature. It found the answer, a frangible tube design, in NASA Tech Brief 63–10304 which reported a development made at the NASA Langley Research Center. The firm says the transfer is considered "an insurance policy worth $100 per year per machine to us."

(MR–6611, LAT–6601)

RDC REFERRAL SERVICE SAVES CLIENT MONEY

Regional Dissemination Centers frequently refer their clients to additional sources of information to supplement the information provided from NASA. One such case involved an Oklahoma company in need of a shroud material to connect a vibrating conveyor to an exhaust plenum in a glass products manufacturing operation. Materials being tried by the company were lasting less than three weeks. A Regional Dissemination Center, whose personnel were familiar with these types of materials, referred the company to a manufacturer of a nylon cloth impregnated with a specialized fluorelastomer. The material was tested and found durable, saving the company $600 annually in replacement costs.

(MR–6612)

NASA WORK IN THIN WALL CYLINDERS HELPS PRODUCER OF PREFAB BUILDINGS

A manufacturer of prefabricated metal buildings who is a client at a Regional Dissemination Center sought information in connection with a product line redesign project. A computerized search of NASA information by the RDC plus a manual search for supplementary information conducted by the RDC uncovered 375 relevant documents of which 80 proved to have direct value for the company. Much NASA work in design of thin wall cylinders proved useful. As a result, the company saved $35,000 it otherwise would have had to spend in research, it reports. Profits on the redesigned product line are presently running at an annual rate of around $4000.

(MR–6615)

DRIVE MECHANISM IDEA SAVES FIRM $1,000

For a NASA program, Jet Propulsion Laboratory developed a compact cartridge drive to manipulate coded tapes. This was announced in Tech Brief 64–10222. A Missouri printing firm came across the Tech Brief while seeking a solution to a need for a self-contained drive mechanism. The NASA innovation met the need, saving the company $1000 in design effort.

(MR–6616, NAT–6603)

INDUSTRIAL EQUIPMENT MAKER LEARNS TO SHAPE TITANIUM

A producer of industrial equipment in Iowa had to develop a spray nozzle made of titanium, but knew little about shaping and machining titanium. A literature search by a RDC produced the needed information. The company estimates savings in development costs at $5000.

(MR–6617)

NASA INFORMATION KEEPS A CUSTOMER

A small midwestern job shop credits services from a Regional Dissemination Center with saving an important customer. The shop was having difficulty tapping titanium and the customer was demanding immediate delivery. A call to the Regional Dissemination Center provided information on how the taps should be reground to perform the specific application. The customer was satisfied.

(MR–6618)

MOUNTING METHOD USED BY FIRM

An electrical machinery manufacturer, in the development of a new product, faced a stumblingblock in devising a proper mounting method. NASA Tech Brief 65–10104 provided an idea that the firm modified to solve the problem. The Tech Brief described an innovation from Jet Propulsion Laboratory involving the development of a special leaf spring suspension system providing accurate parallel displacements. The company estimates the Tech Brief saved $2000 in professional manpower that would have been required otherwise to solve the problem.

(MR–6619, NAT–6604)

PRINTING FIRM ADOPTS CAMERA ACTUATION TIP

A large printing firm has used the design for actuation of a camera shutter by use of a rotary solenoid and spring, described in NASA Tech Brief 63–10560 as the basis for its own design of a similar device. The original unit was developed for use at the NASA Ames Research Center. The actuation method permits a camera shutter to be operated from a remote location.

(MR–6620, ART–6604)

RDC LEADS SMALL FIRM TO ESSENTIAL DATA

A small Michigan company was faced with a need for a low cost method of reducing welded steel tubular hydraulic reservoirs. Mild steel welded tubing with a ⅛ inch wall thickness 5 inches in diameter had to be reduced to a 3 inch diameter for a length of 2½ inches at one end of each piece of tubing. Several methods were tried without success and the project was behind schedule. The firm called the Regional Dissemination Center at which it is a member and obtained a rapid computerized literature search. The search uncovered an article in a trade magazine that explained how another firm had solved a nearly identical problem. The small company immediately contacted the other firm, obtained the necessary data, and was in production within three days.

(CR–6601)

TWO RDC SEARCHES SAVE $15,000

A northern client of a Regional Dissemination Center reports that two searches by the RDC—on structural damping and origins or aerodynamic noise—saved the firm $15,000 to $20,000 by reducing a development program effort from four man-years to three.

(CR–6602)

RDC SERVICE EXPANDS MARKET FOR SMALL CORPORATION

Services from a Regional Dissemination Center led a small manufacturer of resins to several new markets for his products. Of particular importance was a market thus found for the use of this firm's epoxy resins in production of fluid amplifier blocks.

(CR–6603)

NASA DOCUMENT BECOMES AIRLINE TRAINING AID

As a result of "current awareness" services provided by a Regional Dissemination Center to an airline member, the airline is now using a NASA publication, TMX–53432, "Welding Procedures for Titanium and Titanium Alloys," as a standard training text in its maintenance division. Copies of the document have been distributed to all 12 sites where maintenance training of this type is conducted by the airline.

(MR–6621)

CUTTING PROBLEM SOLVED BY RDC SEARCHING SERVICE

A steel producing client of a Regional Dissemination Center brought to the RDC a problem involving rapid wearing out of saw blades in cutting lengths of continuously cast steel. The RDC conducted a search of NASA technical information, uncovering a document describing a gas dynamics-nozzle exhaust principle. That led to an approach involving development of a novel cutting tool with exceptionally long life.

(KR–6601)

THERMOCOUPLE RANGE DATA PROVIDED BY RDC

A metals producer sought information on thermocouple ranges in a variety of dynamic and difficult atmospheres. The Regional Dissemination Center at which the company is a client uncovered two documents in the NASA information system that provided the relevant information.

(KR–6602)

NASA EXPERTS PROVIDE INFORMATION LEADING TO NEW CAPABILITY FOR FIRM

A research director of a Pittsburgh company needed information on maintainability of certain high vacuum equipment. He had been seeking the information without success. At the invitation of the Regional Dissemination Center of which his firm is a member, he attended a Technology Utilization Conference at Lewis Research Center, where he heard a paper touching on the subject. He later contacted the NASA researcher who authorized the paper, visited with NASA Lewis Research Center personnel with expertise in the area, obtained the desired information, and, as a result, his firm has proceeded with a capital investment program to build a capability for vacuum deposition of various kinds of thin films on steel substrates on a production basis.

(KR–6604, LET–6602)

ARMY COMMAND ADOPTS COATING TECHNIQUE

The U.S. Army Electronics Command at Ft. Monmouth, N.J., has made use of an idea developed at the NASA Langley Research Center and reported in Tech Brief 65–10063. The Tech Brief described a method of developing evaporating boats for inorganic materials by flame spraying a ceramic coating on a refractory metal foil. The method was found useful by the Army in deposition of aluminum and other thin film materials for microcircuitry.

(LAT–6603)

LITERATURE SEARCH BY RDC SAVES SCIENTIST TWO YEARS

A scientist working in electron microprobe analysis of corrosive effects on zirconium alloys requested a retrospective literature search from a Regional Dissemination Center. The resulting documents, he reports, "in two months, brought me up to date; otherwise, I am sure, it would have taken two years to gain as much useful information."

(KR–6606)

RESIDUAL STRESS PROBLEM SOLVED BY TWO DOCUMENTS

A Pennsylvania company faced a continuing headache in being unable to routinely avoid setting up residual stresses in certain workpieces during machining. An information search by a Regional Dissemination Center led to two documents—one a translation of Russian work and the other describing results of work performed for the U.S. Government at a research institute—that, in the company's words, "answered 100 percent the problem we had."

(KR–6605)

TECH BRIEF AIDS IN DEVELOPMENT OF ABLATIVE THERMOCOUPLE

A Massachusetts firm credits NASA Tech Brief 64–10099 and additional information supplied by the NASA Marshall Space Flight Center as having played "a very important educational role in the development of" a new proprietary coating method that has permitted the development of a new line of ablative thermocouples. The Tech Brief reported a refractory coating originally developed to protect certain base regions of the Saturn booster from radiation caused by engine plumes and exhaust gases. The firm was seeking an appropriate coating and asked for literature searches from two universities. The searches brought the Tech Brief to the firm's attention.

(MFT–6603)

COMPANY DEVELOPS COIN-OPERATED GAS PUMP

A small North Carolina firm, established in 1946 to manufacture mobile communications equipment, was seeking diversification through new products. The company came to a NASA Regional Dissemination Center for information on

space technology applicable to its products. Through a computer search, the RDC located a report describing a circuit essential to the operation of a coin-operated gasoline pump being developed by the company. The circuit, which computes the value of coins deposited and translates this into the quantity of gasoline to be dispensed, has been integrated into the overall design for the company's automatic gasoline vendor.

(NC–6701)

SMALL BUSINESS CAPITALIZES ON SPACE RESEARCH

A small company in Fort Wayne, Indiana, was chosen last year by the Small Business Administration for participation in a cooperative SBA–NASA experimental program to introduce the small business community to Regional Dissemination Center services. This company, which designs and builds artificial heart models, immediately received three specific leads for incorporation into its research and development processes: a brushless DC motor, originally developed for satellites lending itself to both reliability and compactness, was adapted to refined heart models; several computer programs for making calculations in evaluating pump test results were employed saving the company 200 man-hours in development time and leading to increased pump efficiency of 30 percent; and reliability forecasting techniques, developed for space program reliability and quality control, were applied to evaluating and predicting performance of heart models.

(KR–6701)

COMPANY ADDS TO PRODUCT LINE

A NASA developed complex wave generator has been incorporated into a manufacturer's commercial product line. The low-cost design was developed for specific acceleration qualification of components for the Centaur rocket.

(LET–6607)

NASA TECHNOLOGY SPURS RADICAL NEW APPROACH

The chief engineer of a large company in the heating and ventilating equipment business is very enthusiastic about the NASA publication "Advanced Bearing Technology" (NASA SP–38) since it gave them highly relevant state-of-the-art information they needed for a radical new approach they are making in a water-cooled bearing where they had not been able to solve certain problems in performance over a wide temperature range, difficulties with seals, etc., until this information came along.

(MR–6501, LET–6502)

UTILITY COMPANY SOLVES METAL POROSITY PROBLEM

A large utility company, performing research on advanced power conversion techniques, had been plagued with a problem of metal porosity. A Regional Dissemination Center was able to supply information which, while developed by the NASA for a completely different purpose, solved the utility's problem. The Chairman of the Board stated that the potential value of this one transfer must be predicted to be in the *multi-million dollar range*, when the new energy system becomes commercially useful.

NEW PRODUCT INCORPORATES NASA REGULATING VALVE

A firm in Minneapolis, Minnesota, will place on the market a commercial product incorporating the regulating valve for flexible tubing. The product is proprietary information. The firm first learned of this valve through an Innovation Announcement sent out in a regular mailing of a Regional Dissemination Center.

(MR–6503)

SMALL FIRM IMPROVES PRODUCT RELIABILITY

As a result of a publication discussing and illustrating causes of failure in semiconductors, engineers in a small firm were able to pinpoint the cause of

failure that had been creeping into one of their devices. As a result, the reliability of one of their semiconductors devices was greatly improved. Any dollar value assigned to this transfer of technology would be purely speculative at this time.

(AR–6507)

FIRM UTILIZES PROCESS TO MAKE MIRRORS

A private firm is using a modification of a NASA technique to polish metal masters for shaping elliptical glass mirrors to be used in bowling score projectors. Presently, 400,000 such mirrors are being produced. The same company reports that this method also has utility for polishing combination aspheric-parabolic surfaces.

Another company, through consultation with the firm mentioned above has used the modified method to produce an aspheric collector lens for a light concentration system.

(GDT–6611)

CLINICAL GROUPS USE SPRAY-ON ELECTRODES IN TESTS

At the NASA Flight Research Center, a new technique for applying electrocardiographic electrodes to test pilots was developed. A liquified, conductive mixture is sprayed over the ends of lead wires into the patient's chest. The coating dries quickly, is thin, flexible, and not uncomfortable, and can be easily removed—but will keep the electrodes in contact with the skin during exercises causing perspiration. Clinical groups are now using the technique to gather data on patients and medical test subjects while exercising.

NASA WORK LEADS TO NEW EDUCATIONAL DEVICE

A Midwestern company is marketing a new educational device internationally. The portable planetarium permits a student, virtually at a glance, to determine the relative positions of the planets on any given day between the years 1900 and 2000. A Jet Propulsion Laboratory technician, who has for years been making lunar and planetary spacecraft trajectory models for NASA, compressed much of that knowledge and computer analysis into developing this device.

(NAT–6605)

ELECTROMAGNETIC HAMMER ASSISTS SHIP AND CAR BUILDERS

Shipbuilders and automobile manufacturers are experimenting with a tool developed at the Marshall Space Flight Center to smooth and shape metal without weakening it. The magnetomotive hammer was first developed to remove weld distortions in booster components of large rockets.

(MFT–6607)

DEVICE DEVELOPED FOR THE MOON SEES EARTH USES

A company is manufacturing and marketing a seismometer designed to withstand the extremely high impact shock of a lunar landing. The device can be applied to detect and measure the effects from underground explosion and also to study the effects of earthquakes or tremors on large structures. The firm has sold twelve of these devices, to date, to seismic observatories; and has been able to reduce the selling price by 40%. Further price reduction is expected.

(GDT–6609)

DC TO AC CONVERTER SEES MULTIPLE USES

A New England electronics firm is using a NASA developed self-oscillating converter as the basis for a battery operated DC to AC inverter in an aviation runway system. The lightweight, portable system consists of a number of plastic tape electroluminescent lamps operated from batteries by the NASA device.

A large semiconductor manufacturer has recommended the inverter circuit design approach to several customers as a solution to specific application problems. Additionally, a western research institute has reported possible use for this innovation in experimental research in cloud physics.

(GDT–6610)

CIRCUIT FILLS NEED WITHOUT MODIFICATION

A South Dakota firm specializes in the design and development of telemetry units for high altitude research balloon systems. Generally, the requirements of these systems include the minimization of size, weight, and power consumption. The company recently had a need for a compact, high input impedance solid-state amplifier circuit. The circuit in Tech Brief 64–10143 was the ready-made answer to their problem, and they were able to apply it without any alteration.

(MR–6543, ART–6501)

NASA TECHNIQUES LEAD TO SHOP IMPROVEMENTS

A Nebraska company has been helped in various ways by RDC information on (1) jigs and fixtures, (2) welding, and (3) galvanizing. The company is now getting better protection, through a cold galvanizing technique, of welds on counter tops, window louvers, and shop tables which are subject to either hard wear or weathering. This new procedure can be performed on site where formerly the work would have been sent out, thus resulting in a cost saving. The firm is also using Lewis Research Center "electric razor" method of etching or roughing metal giving them a new capability of getting into tight spots and avoiding removal of too much material.

(MR–6544, LET–6501)

RDC SERVICES IMPROVE PRODUCTION—EXPAND PRODUCT LINE

A small electronics firm regularly receives RDC mailings and reports extensive use of information provided. Two specific examples are NASA Tech Briefs 64–10069, "Metal-Bending Brake Facilitates Lightweight Close-Tolerance Fabrication," and 64–10171, "Subminiature Biotelemetry Unit Permits Remote Physiological Investigations." The bending brake described will be used in the company's production operation, and the biotelemetry unit will become an addition to their product line.

(MR–6562, ART–6602, ART–6503)

COMPANY IMPROVES WELDING TECHNIQUES

An Oklahoma manufacturer of heat exchange equipment has demonstrated interest in innovative welding and fabricating techniques for heavy equipment. As a result of an RDC presentation, and subsequent visits at the company by RDC personnel, the firm has adopted the use of fiberglass back-up tape in welding operations, especially for bevel welds with lighter weights of metal, including stainless steel.

(MR–6525)

RDC SERVICES AID GRADUATE STUDY

An immediate savings of $1,600 and a definition of future research directions for graduate students have been realized by a university professor through RDC assistance in obtaining bibliographies on flight mechanics, optimization techniques, variational methods, and hydrodynamic lubrication. The professor is also using this computer located material to keep his classes up-to-date with current examples of contemporary applications of classical methods.

(NC–6557)

ELECTRONICS COMPANY SAVES $15,000 ANNUALLY

Yearly savings of $15,000 have resulted for an electronics company. The firm was greatly disturbed by the high number of rejections of assemblies due to bad joints and joint failures. Through reference to NASA SP–5011, *Welding for Electronic Assemblies*, company personnel were able to determine proper settings, isostrengths, electrode materials, repeatability, and distribution curves resulting in process control and proper inspection procedures.

(NC–6612, MFT–6501)

SPACE TELEMETRY MONITORS HOSPITAL HEART PATIENTS

A telemetry unit, developed under contract to Ames Research Center, is being used in a hopsital intensive care Cardiac Monitoring Unit. The original device was designed for monitoring the electrocardiograms of astronauts under diverse, ambulatory conditions. The adapted version is excellent for monitoring a heart patient while permitting the patient to move freely within 100 feet of the receiver. Previous EKG equipment required the patient to lie still, encumbered by unwieldy electrocardiograph wires.

The system in use consists of three transmitters and five receivers bought from the original developer, who is marketing the units at $1,600 each, in conjunction with another firm.

(ART–6605)

WALKING CHAIR DEVELOPED THROUGH NASA RESEARCH

A six-legged vehicle proposed as an instrument carrier for unmanned exploration of the Moon has been adapted by a California company as a walking chair that can carry crippled children over rough terrain and obstacles that would stop an ordinary wheelchair.

(NAT–6605)

SILICONE LUBRICANTS AID MANUFACTURER

A manufacturer of rubber components was encountering difficulties in the lubrication of a pressure transducer which was designed to operate at 320°F and 2,500 psi. Through a routine mailing from a Regional Dissemination Center, the company learned that silicone lubricants should perform better than conventional lubricants in this particular application. Use of these lubricants, although still being perfected, has already significantly improved the operation of the transducer.

(MR–6522)

SIGHT SWITCH USED BY HOSPITAL PATIENTS

An Alabama firm has developed a switch actuated only by the voluntary movement of the eyes. The sight switch is an infrared transmitter and detector that operates on the principle of differential reflectivity between the white and iris of the eye. Thus it can be actuated by simple sidewise eye movements. The switch is being used in hospitals to permit patients to gain some control over their environment.

(MFT–6502)

COMPUTER PROGRAM SAVES 100 MAN-HOURS

A computer program developed by the NASA Space Nuclear Propulsion Office simplifies the selection of steel columns and base plates in the construction of multi-story structures. Reported in Tech Brief 66–10097, the process has proven useful to several companies. One user reports it saved his firm 100 man-hours.

(NUT–6501)

SALES EXCEED $150,000

NASA requirements for an extremely low pressure measuring ionization gauge for use on satellites has resulted in the development of a Cold Cathode Ionization Gauge. The device employs a high voltage discharge in the presence of a magnetic field to obtain an ion current that is proportional to the gas pressure within the gauge. Commercial sales of this product have already exceeded $150,000.

(GDT–6503)

SALES REACH $30,000

A Colorado firm, under contract to NASA for work on the Orbiting Solar Observatory Satellite, developed a unique temperature transducer to meet stringent requirements of linear output, small size, sufficient voltage and stability. After

receiving a royalty-free license from NASA to commercially manufacture the device, the firm has marketed the instrument with sales, to date, of approximately $30,000.

(GDT–6504)

COMPANY RECEIVES MULTIPLE BENEFITS FROM TUNGSTEN WELDING PROCESS

A manufacturing company was using soldering for a particular thin metal (.004" to .006") joining operation. They were interested in better techniques for doing this same job. A retrospective search identified the Tungsten-Inert-Gas (TIG) welding process. Since then other searches in this area have supplied them with valuable operating parameters for best performance of the equipment. They have, at this time, invested about $10,000 in two welding machines and, after a period of further testing and training, plan to purchase more equipment for introduction into their production operation.

This technique will eliminate several component parts now required in the assembly. It will effect a significant man-hour saving on the assembly line. It extends the usable temperature range of the manufactured part. It provides an inhouse capability to manufacture component parts which were previously purchased.

(AR–6505)

HEAT SINK BOOSTS DEVELOPMENT

One of the special capabilities of a small firm is the design and development of electrical power conversion units. One unit in particular involves DC–AC–DC inversion/conversion for a railroad company. An executive of the company says that they were able to reduce the temperature derating factor on their power transistors by using the heat sink material and technique of NASA Tech Brief 63–10033, "Indium Foil with Beryllia Washer Improves Transistor Heat Dissipation."

(MR–6529, GDT–6503)

COMPUTER PROGRAM FOR BEARING DESIGNS REVISED

Through the Selective Dissemination Services and Industrial Applications Services a company was made aware of the "Advanced Bearing Technology" report (NASA SP 38). They subsequently used information from several chapters to *revise their computer program for bearing designs,* and, although no specific value can be assigned to this result, it obviously enabled the company to move forward its state-of-the-art in bearing designs.

(AR–6506, LET–6502)

COMPANY USES TEMPERATURE SENSITIVE CIRCUIT

A manufacturing firm in St. Louis, Missouri, was seeking an improved means of controlling the speed of a condenser fan motor in proportion to a change in temperature. The temperature sensitive circuit described in NASA Tech Brief 63–10537 appeared to be applicable and prompted a call to a Regional Dissemination Center for suggestions on the type of temperature sensitive diodes to be used. A diode type was suggested, and this circuit is now being employed by the company in the laboratory model of a temperature control system.

(MR–6545, NAT–6501)

PRECISION CASTING TECHNIQUE PRODUCES BETTER VALVE

A medium size firm in St. Louis, Missouri, manufacturers butterfly valves used in breweries. As a direct result of reviewing information from NASA they modified the process used to manufacture the butterfly flapper in their lager valve. Prior to adopting the process described in Tech Brief 63–10008, the part was made of one stamped piece and one machine-turned piece welded together. The new part is smooth, is held to a tolerance of ± 0.003 in., requires no cleaning and is a one-piece casting. This change of manufacturing process has several definite cost saving advantages, including the complete elimination of several broaching operations that were previously required.

(MR–6506, ART–6504)

NEW TECHNIQUES IMPROVE WELDING CHARACTERISTICS OF HIGH NICKEL ALLOY

A manufacturer of high nickel alloys had been receiving documents from a Regional Dissemination Center related to the alloying of special metal compositions. The company incorporated techniques from these documents into its production operations. The result has been the improvement of the welding characteristics of a number of the company's products.

(NC–6527)

SPACE TELEMETRY IMPROVES FM BROADCASTING

A North Carolina firm is developing a FM sub-carrier generator for use in a background music transmission system. An RDC provided the chief engineer at the company with a NASA Tech Brief (65–10055), describing a solid-state FM oscillator used in space telemetry. NASA provided further information on the innovation, and the circuit was adapted to an improved FM sub-carrier generator, which takes up only one-tenth the space needed by formerly used apparatus. It is also more reliable, requires less maintenance, costs less than 1/10 as much as the former unit and uses only 1 watt of power instead of 500 watts.

(NC–6631, NAT–6604)

SEISMIC EQUIPMENT MAY ASSIST BUILDERS IN STUDY OF EARTHQUAKES

A company has been manufacturing and marketing a seismometer developed under a NASA university contract. To date, twelve pieces of equipment have been sold to seismic observatories, and the company's promotional efforts are beginning to create interest in new and related geological fields.

The company has also introduced a package of three mutually orthogonally oriented seismometers for permanent mounting on structures so that components of seismic disturbances about each of the three axes may be obtained to assist designers or builders in their study of the effects of distant quakes on large structures over a long period.

WELDING TECHNIQUES—ELECTRONIC OSCILATOR AID APPLIANCE FIRM

The service department of a large home appliance concern routes the NASA information received from a Regional Dissemination Center to their technical staff. Information contained in the booklet *Selected Welding Techniques* (SP 5003) was put to use in their refrigeration system welding operations.

From one of the Tech Briefs an *electronic oscillator* circuit was incorporated in some of their electronic test equipment.

(MR–6516)

USING SPACE TECHNOLOGY

Machining techniques for pyrolitic graphite developed in the NERVA Program, coupled with earlier work by the Navy, permited a company to develop a smoking pipe lined with pyrolitic graphite and an outer shell of various materials, including plastic. During the second quarter of commercial sale, this item grossed $125,000 sales per month.

IMPROVED ACCELEROMETER DEVELOPED

A firm developed a damped accelerometer to be used to make vibration measurements of Saturn boosters during static firings. This accelerometer avoided the tendency of commercially available models to oscillate or "ring" when subjected to the extremely high shock impulses generated during such firings. The company spent $50,000 of its funds in developing the device further for commercial utility. The company has already sold 250 of the units.

NEW BATTERY SEPARATOR MATERIAL IMPROVES PRODUCT QUALITY

A battery manufacturer, convinced that development of better silver-zinc oxide and silver oxide-cadmium batteries had been held back because of lack of better separation material, worked with a NASA Regional Dissemination Center in searching NASA-sponsored R&D work in this area. The result was information which, after tests and analyses, proved to be just what was needed to improve the company's costs and product quality.

(NC–6502)

COMPANY IMPROVES FUEL CELLS—SALES REACH $20,000 IN SIX MONTHS

A Wisconsin company, under a NASA contract to develop a fuel system for use in the Saturn booster instrument units, developed a method for removing water vapor from H_2–O_2 fuels cells. The new method of moisture removal, utilizing a specially treated asbestos membrane, offered the advantage of being more reliable and lighter than the mechanical pump systems commonly used in earlier fuel cells. In six months, the firm sold $20,000 worth of fuel cells after incorporating into them the static moisture removal system.

PORTABLE TOOLS FOR BRAZING ADDED TO PRODUCT LINE

A Michigan company is manufacturing and selling, as part of its commercial line, portable tools for brazing tubing in areas of limited access. The design was developed under a NASA contract. The company has invested a substantial amount of its own funds to develop the tools further and has proposed the use of these devices to airlines to be employed in repairing jet engines.

NEW COMPANY FORMED TO MARKET DIFFERENTIAL TEMPERATURE TRANSDUCER

The development of a transducer for measuring the temperature differential between the inlet and outlet flow of water coolant in electric arc research resulted from a NASA program.

The transducer is especially effective in measuring temperatures in strong electric and magnetic fields, but in addition to its usage for this purpose, suggested applications are in the chemical process industry, nuclear reactor technology, and internal combustion engine testing, with further use in arc technology, and in specialized high temperature work.

A new company was formed to market the device, and over 200 units have been sold, filling a broad range of instrumentation requirements.

NONDESTRUCTIVE TESTING USED ON REINFORCED PLASTICS

A company which manufactures reinforced plastic tanks, fume ducting and fume scrubbers for the process chemical industry has borrowed NASA technology of nondestructive testing. The company's problem was that existing methods of testing the hardness of reinforced plastic structures punctured the structures and was, therefore, undesirable. Through active searching effort by a NASA dissemination center, a report was placed in the hands of the company which led them to utilize nondestructive techniques to make determinations of the extent of the cure of their reinforced plastics.

(NC–6514)

RDC SERVICES SAVE COMPANY $30,000

A midwestern company was able to overcome cost problems in the manufacture of slip and bush rings for vehicles by using information concerning friction, metallurgy, and lubrication provided by a NASA dissemination center. The approximate cost savings are estimated by the company at $30,000.

RADIO-ISOTOPE DETECTS WELD FLAWS

A midwestern firm which produces a long-length, flexible tub product is investing $10,000 in new equipment and in personnel training to implement a new testing technique for determining the quality of deep-in-the-tube welds. The

technique was located in the NASA literature of inspection techniques and testing methods by a computer search by a NASA dissemination center.

The solution was to utilize a radioactive isotope, suspended in a manner that set it equidistant from all sides of the tube. After the insertion of the isotope, X-ray techniques are applied to record the weld quality.

COMPANY SAVES $35,000

A northern company was able to complete a project requiring the attachment of solar cells to aircraft as a result of information in reports describing attaching techniques provided by a NASA dissemination center.

The accomplishment of this, which had previously held up the project, saved about one man-year of effort on the project, amounting to an approximate dollar saving of $35,000.

DIGITAL PROCESS CONTROL SYSTEMS AID TEXTILE FIRM

A major U.S. textile firm in South Carolina is establishing direct digital process control systems in its textile finishing plant. Use of this automatic control system came as a direct result of the effort NASA had made with such systems in conjunction with test firing of boosters.

Some time ago, the firm decided that computer controlled systems offered many potential advantages in the processing of textiles. A visit to NASA's Marshall Space Flight Center with Marshall's Technology Utilization Officer led to the company's witnessing operation of vehicle check-out systems used during the test firing sequence of Saturn boosters. From this review the firm concluded that the same digital process control system could be applied to textile finishing, and has taken steps to implement such application.

Another company was successful in a proposal to apply an industrial electronic system employing digital techniques to the same major textile firm's looms in a Georgia plant. This company won this award primarily because of the digital techniques it proposed and their superiority over slower and somewhat outdated analog systems.

(MFT–6606)

NASA EVALUATION OF FOAM APPLICATION SPURS INDEPENDENT DEVELOPMENT

One company solved a production problem through the independent development of a specially designed apparatus based upon the evaluation of similar mechanisms found in a NASA document. This company is a manufacturer of fiberglass boats and had been using polyurethane foam for flotation, sound deadening, and rigidity. The inefficiency of its methods led the company to ask a regional dissemination center for assistance.

A computer search quickly retrieved several relevant documents, and one document found in the search of NASA literature described the merits of several types of foam application. Using this material as the basis, this manufacturer decided that he could build an application system which would conform specifically to his needs.

(NC–6519)

NEW DESIGN DATA SAVE ½ MAN-YEAR AND $25,000

A retrospective literature search by a NASA Regional Dissemination Center permitted a company to save half of a man-year plus $25,000 by providing information on new design concepts and design data for high pressure seals.

AUTOMOBILE PANEL FLUTTER REDUCED

Facing a problem of reducing automobile panel flutter which results from aerodynamic noise, a member company of a NASA dissemination center reviewed reports uncovered by the center's computer search on the subject of structural damping and was thereby provided with a rapid solution of the initial problems, which led to initiation of a design phase and development of hardware-prototype solutions to the problem. Approximately $35,000 was the company's estimate of the cost savings.

THIN WALL CYLINDER DATA SAVES $35,000 IN R. & D.

A Missouri company requested from a NASA dissemination center research information on the structural characteristics of thin wall cylinders to bring itself up to date in the design and manufacture of steel tanks and buildings.

The information provided proved to be of direct benefit in the analysis and design of structures using "stiffened bends." They now have both production and experimental products for which the information supplied has served as basic reference. The company saved $35,000 in a research effort and the sales of these new or redesigned products are estimated by the company to run at $50,000 per year.

RDC SERVICES SAVE R. & D. EFFORT

A company produces a silicon controlled rectifier whose turn-off time is approximately 100 μs Document No. AD 430901 referred to several ways that the turn-off time of such silicon controlled rectifiers could be changed. As a result of the techniques discussed in this document, their device No. 5TCR was tested at turn-off times down to 50–60 μs. This device is thus usable over a wider frequency range.

If they had decided to attempt such an experiment without benefit of the document, it would have taken approximately two months of research time by their engineers. With the information given in the document, however, their tests were completed in two days. This alone is worth perhaps $5,000 without considering the increased market potential of the 5TCR device.

(AR–6501)

NASA PUBLICATIONS AID COMPANY

Publications received from a NASA RDC led a Minnesota firm to improvements in bearings supplied on its equipment and to solving a problem in bonding an elastomer to aluminum. The publications supplied were "Advanced Bearing Technology," NASA SP–38, and "Elastomers Bonded to Metal Surfaces Seal Electrochemical Cells," Tech Brief 64–10113.

(MR–6528, GDT–6501)

IOWA FIRM IMPROVES MANUFACTURING QUALITY

An Iowa firm was encountering problems with faulty and non-uniform welds in their die and jig making department. By implementing the technique described in Tech Brief 64–10058, the company was able to improve the quality of the weld to an acceptable level.

(MR–6531, MHT–6501)

COMPANY APPLIES NEW CIRCUIT

A small Arkansas firm designs and develops electronic sub-systems and circuits to meet the specialized requirements of its customers. The company's project engineer says that the circuit technique of Tech Brief 63–10553, "Transistorized Trigger Circuit is Frequency-Controllable," was employed, with minor alteration, in the development of a "black box" for one of his customers.

(MR–6533, GDT–6502)

COMPANY ELIMINATES MANUFACTURING PROBLEM

A large manufacturer of firearms ammunition learned of magnetic metal forming from a NASA RDC. The Center suggested that they use the magnetic forming process to swage a brass ring on one of their standard sizes of ammunition. The firm investigated the process and found it to be completely satisfactory. Tests on the new process indicate that it will eliminate a long standing serious manufacturing problem. The company is proceeding to design the automatic feeding equipment that will be used with the magnetic forming machine.

(MR–6539)

COMPANY USES ULTRASONICS FOR LEAK DETECTION

A large manufacturing company was interested in finding a fast and economical means of detecting minute pin hole flaws in a welded product. A thorough search by experienced Regional Dissemination Center applications engineers provided this company with the necessary information from the NASA Lewis Research Center on ultrasonic leak detection techniques and subsequently put this firm in touch with several commercial organizations which produced such equipment. Timely experiments conducted by one of these firms in conjunction with the RDC client has offered promising preliminary results, which may result in the installation of a quality control system offering a superior product.

(LET–6502)

COMPANY AVOIDS COSTLY R. & D.—SAVES MANPOWER

A company wished to locate a material capable of accommodating high density magnetic fields for use as a core material in a pen-driven mechanism. The firm had developed a magnetically driven servo recorder with only one moving part. The pen, on a drive coil, slides along a one-inch diameter core piece in response to a variable magnetic field. They wanted to produce a model that would handle a larger chart by extending the length of the core piece without changing the diameter. In this way, no retooling would be necessary.

Documents identified through an RDC retrospective search showed that no low cost material existed that would operate at the desired flux densities. Thus the company with able to proceed, without further materials research or experimentation, confident that retooling was necessary to produce the new, larger model. The resulting benefits to the company were: (1) Avoidance of unnecessary R&D project, and (2) an estimated savings in excess of two man-months.

(AR–6502)

ENGINE LIFE EXPECTANCY DETERMINED

A company was considering replacement of several reciprocating gas engine compressors with gas turbine type compressors. The main component of the gas turbine compressor is a standard jet aircraft engine widely used in civil and military aviation. The company desired information and data pertaining to the life expectancy of these gas turbines under conditions of static, continuous use.

Through contact with the Technology Utilization Officer at Lewis Research Center the manufacturer met with NASA, RDC and other industrial personnel to discuss the question. The meeting resulted in the transfer of much valuable information and a consensus relative to engine life expectancy. The manufacturer agreed to collect and provide as much historical data as possible.

The company was able to establish a realistic life expectancy for the equipment in question for amortization and economic evaluation purposes. The meeting at Lewis also generated further interest in the subject of lubrication of the new equipment.

(AR–6503, LET–6502)

AMPLIFIER CIRCUIT IMPROVES PRODUCTION PROCESS

A firm, which specializes in the manufacture of precision wire-wound resistors and temperature controls, reported that they are presently using the amplifier circuit described in a NASA publication "A Compact DC Servo Power Amplifier," (F. S–AC–38) to increase the sensitivity of a standard panel mounted test instrument. "This amplifier allows us to use a more rugged instrument for production line use and still obtain the sensitivity required."

(MR–6565)

COMPANY USES PLASTIC COATING AS ELECTRICAL INSULATION

A small manufacturer of solid-state industrial control equipment sought the assistance of an RDC in finding a means to simplify construction and reduce

size of a power controller it was manufacturing. The RDC furnished information that indicated that a specialized plastic coating approach was the answer to their problem. The RDC supplied additional data on the state-of-the-art of this technique leading the company to the development of a process for the application of a specially developed finish for metal parts which provides excellent electrical insulation and heat transfer. This finish has enabled the company to effect a 75 percent reduction in size of the power controller, while maintaining equivalent power capability. A further design modification has permitted both implication in the manufacturing process and facility in maintenance of the unit.

RUSSIAN AND U.S. PAPERS LEAD FIRM TO SOLUTION

A North Carolina electronics components manufacturer has solved the problem of switch failure in its products, caused chiefly by contact degradation. These switches, produced in a variety of configurations, are employed in high reliability equipment. An RDC literature search directed the company to two Russian and one U.S. paper on electrical contacts and conductive alloys which provided exactly the type of information needed to improve contact materials. The company is presently moving to incorporate these new developments into its product line.

(NC–6523)

SOLDERING TECHNIQUES REDUCE REJECTS

A company in St. Paul, Minnesota, had a quantity production contract on a transistorized digital read-out device which they had designed and developed. In order to minimize unit rejects due to faulty electrical connections, and to insure a high quality of fabrication, it was necessary that they train and educate their assembly line workers on soldering techniques. This need prompted their management personnel to use the handbook entitled, "Reliable Electrical Connections," from the NASA Marshall Space Flight Center as a standard training reference on soldered electrical connections. They feel that the detail description of techniques provided in this handbook *shortened the training time considerably*, and resulted in their reaching peak production much earlier than had been expected.

(MR–6536, MFT–6503)

NEW COMPANY ESTABLISHED

A small new subsidiary company has been established by an Illinois firm specifically to make and sell a modified version of a graph scale interpolator that originated at the Langley Research Center.

COMPUTER TECHNIQUE IMPROVES X-RAYS

A computer technique that was used by the Jet Propulsion Laboratory to enhance television pictures of the Moon and Mars sent back from spacecraft is being developed to clarify and sharpen medical X-ray photographs.

SALES EXCEED $100,000

A coaxial cable cutter and stripper designed by an employee of Ames Research Center is being manufactured and sold by a California firm for $39.95 per unit. Sales of the new hand tool to date exceed $100,000.

MINIATURE TV CAMERA MONITORS INDUSTRIAL PROCESSES

A 24–ounce, battery-powered television camera, as small as a king-size pack of cigarettes, was developed to observe the separation of rocket stages in flight. A commercial model is now on sale for monitoring industrial processes. It could be used by night watchmen and news reporters, in classrooms and operating theaters, and at public meetings to focus on individual speakers from the floor.

AIR BEARING SUPPORTS PATIENTS DURING EXAMINATION

In medicine, the principle of an air bearing in a Saturn V guidance gyroscope has been used in the design of a table that floats on a thin film of air, supporting a patient free of vibrations while the force of his heartbeat is measured.

RDC FINDS RESIN TO FILL SMALL COMPANY'S NEEDS

The chemical division of a small manufacturing and sales company was troubled by the need for a resin of low di-electric constant. The design problem was solved by employing a resin having special properties that had been already developed by the Federal Government. The resin was used in a novel alternator finding much more acceptance now in a specialized market. Furthermore, the Research Director reported that the dialogue with an RDC engineer sparked an idea on how to reach a long-range solution to their problem, an idea which proved correct after laboratory verification.

NEW SOLVENT ELIMINATES HEALTH HAZARDS

A company was seeking an improved method for removing lithography from cans. The removal had been accomplished using chloroform and steel wool, which was a slow, hazardous task.

NASA industrial Applications Report (N64 20321) received from an RDC described a paint remover which was "more efficient and more universally applicable" than the existing systems on the market. Many solvents and removers had been tried without success. After careful study, the company selected an efficient alternate formulation which contained only immediately available chemicals.

The use of this innovation will save the company several thousand dollars annually. It will eliminate a hazardous operation with regard to health. In addition, it has potential applications in plant maintenance.

(AR–6504)

METAL TO METAL BONDING PROBLEM SOLVED

A manufacturer of computer tape reels was experiencing difficulty in meeting a delivery schedule with high quality reels. The major problem involved the attachment of aluminum reel flanges to a cast aluminum hub. Parts assembly by adhesive requiring removal from the tape channel. Assemblies were out of alignment tolerances.

The manufacturer contacted a Regional Dissemination Center and a search of NASA literature was made on adhesive bonding in an effort to find an adhesive which cured at room temperature and could be efficiently applied. Several documents identified specific adhesives suitable for the application and the sources of supply. An applications engineer at the Center recommended several machining modifications to provide a groove in the periphery of the reel hub to act as a trap for excess adhesive to reduce the overflow. Latest reports from the company indicate that schedules are being met and that the assembly problem has been virtually eliminated.

(NC–6530)

NASA COMPUTER PROGRAM ASSISTS TWO ELECTRONICS FIRMS

As the result of receiving basic information on a Marshall Space Flight Center computer program, "Nth Order and Partial Differentiation of Algebraic and Transcendental Expressions by Digital Computer," scientists in two different electronics firms contacted a Regional Dissemination Center concerning further information. Each had reviewed the descriptive information sent to them and felt the program would fit certain of their particular computational problems. Each firm was loaned the complete program deck saving several man months which would have been involved in writing and checking the computer program mentioned above.

(MFT–6503)

PIEZOELECTRIC TRANSDUCER UNDER DEVELOPMENT

One company after evaluation of the technical information presented in the NASA Technology Utilization publication regarding the piezoelectric transducer said, "We are presently working on two applications for this device. One is for microacceleration measurements, and the other is for dynamic chemical weighing. It will be sometime, however, before we have any tangible results. We are proceeding cautiously because of the nature of the potential market."

MARSHALL DEVELOPMENTS AID SMALL COMPANY

The Chief Manufacturing Engineer of a small firm reports that the handbook entitled "Reliable Electrical Connections" from NASA's Marshall Space Flight Center has become a standard reference for their fabrication people.

The company is also preparing to use the device and technique of NASA Flash Sheet M–FS–107 (an instrument for accurate determination of squareness or perpendicularity) in their operation of designing and fabricating aerosal and packaging machines.

(MR–6542, MFT–6504, MFT–6505)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
Washington, D.C., October 24, 1967.

HON. JENNINGS RANDOLPH,
U.S. Senate,
Select Committee on Small Business,
Washington, D.C.

DEAR SENATOR RANDOLPH: Thank you for your October 2 letter. Following are answers to the questions posed in that letter.

1. How has the new technology reporting clause worked? How many reports have been filed each month since it went into effect? Is the number of reports per man hour of scientific and engineering effort about the same for all contractors?

The average monthly number of new technology items reported by contractors is as follows (by calendar year monthly averages):

1963: 24 per month.
1964: 27 per month.
1965: 64 per month.
1966: 214 per month.
1967: 292 per month (based on first seven months).

We have learned the necessity of taking the following actions to assure that the requirements of the New Technology Clause will be effectively met: (a) To establish contractor performance standards for new technology reporting; (b) To work with contractors to develop improved systems and procedures for identification and documentation of new technology; (c) To provide written definitions of the scope of new technology and the required depth of documentation; (d) To provide the resources required for the appointment by the contractor of personnel to administer the new technology reporting procedures within the contractor installations.

As a result, contractor reporting has risen substantially in recent years as indicated by the figures noted above.

The number of reports per man-hour of scientific and engineering efforts varies greatly, not only from one contractor to another, but also among various projects within a single contractor installation. This is to be expected, since the volume of new technology generated under a contract depends on a great many variables, including the state of the art in the various fields drawn upon for the particular project, the degree to which the state of the art must be advanced by the contractor in order to meet the objectives under the contract, the mix of effort (research, development, design, testing, etc.) under the contract, the degree of reliability requirements imposed (the higher the reliability requirement, in general, the more conservative the engineering approach and the larger will be the portion of the effort devoted to evaluation and testing), and many other factors.

Further, one item of new technology is not equal to another in novelty and significance. Thus statistical measures alone are inadequate in determining contractor performance in respect to the New Technology Clause. We have, therefore, developed more definitive methodologies for determining the volume of reporting to be expected under various types of contracts.

The broader requirements imposed by the New Technology Clause, of course, have resulted in a larger volume of contractor reporting than experienced under the more traditional patent clauses.

2. What are your criteria for screening the bits and pieces of technology to avoid too much insignificant information being carried into the system? Have the criteria changed with experience?

This is a multi-step process at NASA and a matter to which we have given considerable attention because of its importance. We have two screening systems for the two different sets of information that serve as the raw material for the NASA Technology Utilization Program.

Let me first mention the process for the report literature and published literature that is collected and brought under bibliographic control by the NASA Scientific and Technical Information Division within the Office of Technology Utilization. The report literature is carefully screened for relevance, significance, and non-duplication by technically educated professional personnel with a breadth of experience. The documents that survive this screening are abstracted, indexed, and announced in *Scientific and Technical Aerospace Reports*, a bimonthly abstract journal sold through the Government Printing Office.

The published literature is carefully screened against similar criteria by the American Institute for Aeronautics and Astronautics, under contract to NASA. Those documents surviving this screening are abstracted, indexed, and announced in *International Aerospace Abstracts*, a bimonthly journal available on subscription from the AIAA.

The documents referenced in both those journals are indexed on a single computer tape system, which now contains references to more than 300,000 documents. These tapes, updated twice monthly, are the basic search tool of the Regional Dissemination Centers.

The other evaluation or screening system is that for the inventions, innovations, discoveries, and other incremental advances in the state of the art that are reported by NASA contractors under the New Technology Clause in their contracts or that result from work in NASA laboratories. This is really a two-step process. An initial screening is performed at NASA installations. This is followed by depth evaluation of the remaining items at one of three not-for-profit research institutes under contract to NASA. They judge the novelty and significance of the technology. Criteria for that purpose exist and are submitted as Attachment A to this letter. But to avoid high costs associated with handling a large volume of items of little or no commercial value that might otherwise be initially reported, we have set forth in detail, for NASA contractors, the definition of new technology in NASA Handbook 2170.2, entitled "Reportable Items under the New Technology Clause." That Handbook is forwarded herewith as Attachment B. Additionally, to obtain the optimum efficiency in the new technology identification effort, we have issued another handbook for contractors. This is NASA Handbook 2170.1, entitled "Management Guidelines for New Technology Reporting to NASA." It is submitted herewith as Attachment C. Further, a critical step in the technology transfer process is the method and depth of documentation of new technology. Inadequate documentation, of course, discourages use. Thus we have drafted documentation standards for the use of NASA personnel and NASA contractors in submitting new technology in the Technology Utilization system. These standards exist in draft form, are currently being reviewed, and we expect to issue them within two months.

3. NASA cannot now develop promising technology further to make it more readily adaptable to civilian use. Is this inhibiting transfer success? How could certain technologies be chosen for lifting up to a "threshold" for transfer?

We doubt the practicality of mounting a program of this type except in very special circumstances. An item of new technology developed for aerospace use can frequently find several commercial applications. However, for each of those commercial applications, a different kind of adaptation would be required. Since the social and economic benefits of each adaptation are difficult to measure in advance, the basis for choosing which items to adapt, and for what purpose to make such adaptations, would necessarily be a faulty one. The marketplace probably remains the best determinant of priorities for engineering investment.

There are, however, cases where NASA develops new concepts or systems that—with adaptation—have great potential utility in public areas, such as health care, physical rehabilitation, safety, and law enforcement. Our current thrust is to bring such technology rapidly to the attention of other federal agencies with missions in those areas. As one example, a photo enhancement technique, developed for NASA to clarify photos telemetered to earth from the moon and Mars, has been brought to the attention of the National Institutes of Health because of its applicability in clarifying X-ray images. In another case, much NASA technology is routinely being brought to the attention of the Social

and Rehabilitation Service of the Department of Health, Education and Welfare under the terms of an interagency agreement. Similar agreements exist with other agencies, including the Office of Law Enforcement Assistance in the Justice Department and the Bureau of Reclamation in the Interior Department. One additional example relates to a cooperative effort between NASA and Bureau of Public Roads in which the results of NASA research in aircraft tire hydroplaning have played a key role in programs now underway in several states to modify highway surfaces to reduce accidents under rainy and wet conditions. In a pilot project carried out by the State of California, these techniques reduced accidents by more than 93 percent. Many similar opportunities exist, but such efforts obviously require resources on the part of both NASA and the cooperating agency in order to be comprehensive and effective.

4. How many regional dissemination centers would be necessary to do a nationwide job for all Federal agency technology? Which of the several experimental forms look most promising?

The Regional Dissemination Centers are experimental. Each was established to test a certain set of hypotheses about how the transfer process might be improved.

Each center also has a different institutional base. ARAC is located within a graduate school of business at a university; CAST is in a university division of urban extension; KASC is in a computer and information sciences center at a university; ASTRA is in an independent not-for profit research institute; TAC is in a university bureau of business research; TUSC is in an undergraduate collegiate department; NCSTRC is within a state board of science and technology drawing upon several academic institutions for staff support; WESRC is in a university research institute for business and economic; NERAC is in a graduate school of business administration with special ties to other university departments.

Each also employs a different approach in defining client interests.

Each has developed different sets of services, principally in response to the major industrial needs of the region.

Each is experimenting with a different fee structure.

Each has undertaken a different set of pilot projects aimed at developing new and different services of value to industry.

Each adds to the information resource provided by NASA other information resources necessary to respond to the needs of its current and potential clients.

Thus a very large number of interrelated variables must be analyzed to determine what experimental form is best for serving what kinds of regional and industrial interests. This analysis is a continuing one at NASA, but it is too early to draw any generalizations from the limited experience to date.

5. Are the NASA RDC's going to be asked to pay for the information supplied to them for dissemination as a part of the self sustaining requirement? If not, why not?

We expect that the Regional Dissemination Centers will pay for the information resources provided to them at some point where they can afford to do so, consistent with overall agency dissemination policy.

6. Please comment on the testimony that NASA RDC's "compete" for customers on a nation-wide basis. In what sense are they regional?

The requirement for the Regional Dissemination Centers to become self-supporting is a serious one. Thus they must mount active efforts to alert potential industrial users to the availability of services from them. The market-place thus is permitted to function and the determination of whether the concept of these experimental centers will prove useful to industry as transfer mechanisms is based on real experience. Drawing tight boundaries within which each should operate would be an interference with the marketplace. Thus some competition among centers exists—and, in this case as with other products and services, such competition has a tendency to upgrade the quality of the service and improve the responsiveness to the needs of industry. Further, drawing geographic limits would have the effect of forcing a company to obtain its service from one institution, whether or not that company felt that the particular institution in its region was the best equipped to meet its needs. Each of the Regional Dissemination Cen-

ters is unique in one or more aspects. Each has responded to the peculiar needs of industry in its locale, developing special expertise in the handling of the kinds of problems most frequently posed by that industrial complex. KASC, at the University of Pittsburgh, for example, has responded particularly to the materials producing and metal-using industries which make up the bulk of the industrial base in its region. TAC, at the University of New Mexico, has developed special expertise in the handling of problems associated with the natural resources industries. Services are now being exchanged among the Regional Dissemination Centers in an attempt to capitalize on one another's special capabilities. Thus, the centers are truly regional in that they are responsive to the needs of industry in their regions. But, by adhering to the principles of competition, service to industry is upgraded.

7. On page 31 of your prepared statement, the number of fee paying companies was up from 145 to 286. How many dropped out in that year and what is the total number of companies that have ever been members? If 22% renewed for higher rates of service, how many renewed for lower rates?

During calendar year 1966—the year referenced in testimony and the latest year for which complete data is available—33 companies dropped their memberships in Regional Dissemination Centers. During 1966, only two companies renewed memberships for lower fees than in previous years—or eight-tenths of 1 percent vs. the 22 percent who renewed their memberships at higher fees. The total number of companies served by Regional Dissemination Centers, on a fee-paid-for-services-rendered basis, since the origin of the centers, is 388. That does not count those who have received services of an ad hoc or one-time nature. (Regional Dissemination Centers do offer services other than annual membership services. For example, a company might obtain a single retrospective searching service.) The figure also does not include the 900 companies serviced by one of the Regional Dissemination Centers (Midwest Research Institute), without charge, during the early years of the program before the more comprehensive and more useful fee services were established.

Within the last nine months, all of the RDC's have changed their pricing structures. In nearly all cases, prices were revised downward. Thus, in 1967, many companies will renew their RDC memberships for services equal to or greater than those previously received but will pay lower fees for the services. This change in pricing reflects experience on the part of the RDC's, plus economies of scale associated with an increased client base, plus a deliberate attempt to make the services more attractive to smaller firms.

During the hearings, as you note, Senator Nelson also asked us to provide a breakdown of who is making the inquiries for additional information about the items of technology announced in NASA Tech Briefs and Technology Utilization publications and where they are and what kinds of organizations they are.

We have an analysis underway that will reveal in detail the characteristics of those who have inquired. This analysis will reveal the nature of the inquiries in terms of product lines and market orientation of the companies, in terms of the technical areas of inquiry, in terms of the job functions of the personnel making inquiry, and other factors. This analysis, however, will not be complete for several more months. However, the first portion of this analysis—geographic location of inquirers and size of company of inquirers—will be completed within the next twelve days, and we will forward that information to you at that time.

Sincerely yours,

RICHARD L. LESHER,
Assistant Administrator for Technology Utilization.

Enclosures.

ATTACHMENT A. EVALUATION CRITERIA

(Draft of Revised Standards)

SECTION I. INTRODUCTION

Technology reported by NASA Centers and Contractors through the Technology Utilization Program is screened and evaluated to determine the most efficient method of dissemination. The methods and criteria discussed in this

report are those used in making publication decisions for Tech Briefs and Compilations. This report outlines the basic evaluation methods and discusses their application to specific cases. Criteria for selection of individual items are carefully defined and step by step procedures for application to specific cases are desribed. As considerable judgment as to novelty, significance and technical accuracy of individual reportable items, is required on the part of the evaluator using the criteria, the report can be best applied as a guideline. The use of specific criteria should not restrict or inhibit the creativity of the evaluator. The transfer of technology from one sector of society to another can be best served by an independent, creative and objective recommendation by the evaluator as to the most effective method of dissemination.

SECTION 2. GENERAL DEFINITION OF THE EVALUATION PROCESS

2.1 Elements of the evaluation process

To discuss or define a process clear definitions of its functional and material components are required. The evaluation process, as discussed in this document, involves five components: criteria, items to be evaluated, evaluators, thought and evaluation procedures, and recommendations. These five basic components, and a procedure for continuously monitoring the validity of the evaluation process, encompass the entire concept of evaluation as treated in this document.

2.1.1 Criteria

Webster's defines criterion as "a standard of judging; a rule or test by which anything is tried in forming a correct judgment respecting it." Criteria used as a means of forming judgments should exhibit three characteristics. First, the criteria should be of an objective nature. That is, the rule or criteria should form an evaluation based on factual evidence rather than opinion. Objective criteria can be applied in a non-emotional, detached fashion and should thus aid in the formation of effective, unprejudiced judgments. Second, criteria should be carefully validated by determining their effectiveness in helping an individual form a judgment. The desired result of a set of valid criteria is to achieve judgments which more effectively help an individual or an organization move towards its ultimate goals. The third characteristic which criteria should exhibit is usability. Besides being objective and valid, criteria should be stated in a clearly defined, understandable fashion. If they are not, no evaluator, no matter how competent he is, will be able to effectively apply the criteria.

2.1.2 Items to be evaluated

One of the material components of the evaluation process is the item to be evaluated. For the NASA Technology Utilization program, the item to be evaluated is generally a technical report describing in detail a piece of "New Technology," as defined in NASA Handbook NHB 2170.2 "Reportable Items Under the New Technology Clause." This "New Technology" (submitted as a "Reportable Item") should be carefully and fully documented in accordance with requirements stated in NASA Handbook NHB ——— "Documentation Requirements Manual for Reportable Items." The documentation requirements clearly delineate the information content needed for an item to be effectively evaluated within the Technology Utilization Program.

2.1.3 Evaluators

The evaluator is the key element in the evaluation process, since it is his responsibility to objectively evaluate the Reportable Item by comparing it with the evaluation criteria. The technical background of the individual or individuals performing an evaluation of a Reportable Item generally falls into one or both of two categories: the evaluator(s) may be a practicing member of the sector of science/technology in which the New Technology falls; and/or the evaluator(s) may be a practicing member of a sector of science/technology in which the New Technology has probable or potential application.

There are certain desirable characteristics which an ideal evaluator (assuming acceptable technical competence) should exhibit. These are:

a. The evaluator should exhibit a positive attitude towards the NASA Technology Utilization Program and its goals.

b. The evaluator should be capable of providing objective non-emotional, evaluative judgment.

c. The evaluator should not be ego-involved with the item to be evaluated. His professional status or reputation should not be either positively or negatively dependent upon the results of the evaluation.

d. The evaluator should have a high degree of intellectual integrity. If unfamiliar with the primary or secondary fields of technology, then he should admit this and avoid performing a non-qualified evaluation.

2.1.4 Thought and evaluation procedures

The evaluation process contains two functional components, the thought and evaluation procedures, which must be jointly discussed. The evaluation procedure is a set of logical steps in a decision-making process, whereby the evaluator attempts to objectively apply the criteria to the item being evaluated. The evaluation procedure may be thought of as a structural framework to guide the thoughts of the evaluator during the evaluation procedure.

One such technique is a carefully structured evaluation form, designed to provide the evaluator with constant reminders of the criteria to be used and to loosely guide his mind through a logical thought pattern. An evaluation form so designed will generally elicit most of the information required for a proper evaluation. It should be noted that an evaluation form should *not* be structured so that an evaluator cannot exercise the processes of creative thought.

Another technique of evaluation procedure is an interdisciplinary discussion group, brought together to review items with possible applications in more than one sector of technology. In this evaluation procedure, all of the evaluators should be familiarized with each item to be discussed prior to the group meeting. The discussion group should be moderated or guided by a non-evaluator familiar with the evaluation criteria, the goals of the evaluation process, and the skills of group dynamics.

2.1.5 Recommendations

The end result of the evaluation process should be an objective statement of the evaluator's judgment of the item, with respect to the defined criteria, and a final recommendation. The objective statement of the evaluator's judgment should clearly indicate the degree to which the evaluated item fulfills each of the criteria. Thus, the explanatory text of each recommendation should objectively support the final recommendations. The final recommendation in the NASA Technology Utilization reporting and evaluation system is designed to indicate to NASA's Technology Utilization Division whether an item should be publshed and disseminated, what format or type of publication should be the dissemination medium, and what sectors of the economy the item might interest.

2.2 Functional flow of the evaluation process

The five components of the evaluation process combine to produce evaluative, and hopefully objective, process through which each item flows. The flow of an item through various evaluative functions involving the components is described in detail in Chapter III of this document. At this point, it should be noted that an item generally passes through three levels in the evaluation process. These are the Prescreening Documentation Review, the First Level Evaluation (Preliminary Screening), and the Second Level Evaluation (In-Depth Review).

The Prescreening Documentation Review function is designed to determine whether an item contains minimal sufficient information to permit execution of the First Level Evaluation.

The First Level Evaluation is structured to screen out of the evaluation process any items which are very low in novelty and/or significance or which have other significant limitations. At this level of evaluation, a more stringent review of the documentation content is undertaken to determine if sufficient information is present to permit execution of the Second Level Evaluation.

The Second Level Evaluation is structured to perform an in-depths review of an item with respect to NASA's criteria for the publication and dissemination (issuability) of New Technology.

2.3 Technology utilization publications

The two Technology Utilization Publications which will be disusssed in this document are the Tech Brief and the Compilation. There are other types of Technology Utilization Publications; however, the Tech Brief and the Compilation are highly relevant to this discussion of the NASA Evaluation Process for two reasons. First, these two publications generally receive wider dissemination and industrial usage than other Technology Utilization Publications. Second, the Tech Brief and the Compilation tend to define the minimal requirements for recommendations to publish technical material within the NASA Technology Utilization Program.

2.3.1 The tech brief

The NASA Tech Brief is generally a one or two page description of a single item evaluated as utilizable new technical information. The Tech Brief does not generally contain enough technical detail to enable an interested potential user to immediately duplicate the technology. Rather, it is generally a descriptive abstract intended to serve as an announcement of available technical information, for which the complete details may be requested.

The item of new technology announced via Tech Brief publication should exhibit one or more of the following characteristics:

a. The item should exhibit a moderate to high degree of novelty, either within its sector of technology or in an interdisciplinary application.

b. The item should appear capable of generating a moderate to high degree of interest within some identifiable technical sector, discipline, industry or other definable segment of a user audience.

c. There should be no doubt of the item's technical competence in fulfilling the function for which it was conceived. (Concepts may be exceptions to this characteristic.)

Generally, the Tech Brief publication attempts to call novel, significant, and competent technical information to the attention of a large potential user audience. Such technical information may include, but is not limited to:

a. basic scientific information, scientific or technical explanations of scientific phenomena, and mathematical relationships in support thereof;

b. unproven concepts and conceptual designs;

c. materials, components, systems, sub-systems, and products;

d. properties and treatments of materials and other compositions of matter;

e. processes and techniques for using, developing, designing or manufacturing any of the above;

f. physical property data, environmental test data, and partially analyzed data;

g. computer programs and programming techniques;

h. advances in management techniques, significant applications of known management techniques, and hardware useful in the support of management;

i. methods or means for analyzing, testing, documenting or evaluating any of the above, and new applications of any of the above.

2.3.2 The compilation

The NASA Technology Utilization Compilation is a multipage publication, which generally includes detailed descriptions of fifteen or more items of utilizable technical information. The items included in a compilation are not significant enough in terms of novelty to warrant publication as a Tech Brief announcement. However, a group of items falling into a narrow segment of applied technology, such as machine tools and techniques, soldering techniques or electrical cables and connectors, may be worthy of publication when grouped together.

As with the Tech Brief, the technical competence of an item of utilizable technology should be verified prior to publication.

The scope of technical information which may be presented in a compilation is the same as that of the Tech Brief.

SECTION 3. THE NASA TECHNOLOGY UTILIZATION EVALUATION PROCESS

3.1 Criteria used in the evaluation process

Section 2 defines "criteria" and states the requirements or characteristics they should exhibit. The NASA Technology Utilization Program uses three basic criteria for evaluating its technical information inputs. The same criteria are used for deciding if an item of information should be disseminated in the Tech Brief or Compilation format. These three criteria are Novelty, Technical Significance, and Technical Accuracy or Competence.

An additional criterion is contained, implicitly, in NASA Policy Directive NPD 5700.2, Paragraph 4. This paragraph defines scientific and technical contributions for the purpose of awards by stating that ". . . a contribution having 'significant value in the conduct of aeronautical and space activities' must be an item that contributes to the advancement of aeronautical or space science or operation and has demonstrable value and utility." It should be noted that this criterion for NASA Awards has two components:

a. The item must contribute to the advancement of aeronautical or space science.

b. The item must have demonstrable value and utility.

The first of these two components is automatically fulfilled by all technology published in the NASA Technology Utilization Program, since by definition the technology is specifically developed for NASA use. However, the second component of the criterion, "demonstrable value and utility," is left essentially open ended, in that the obvious question of "value and utility to *whom?*" is not explicitly answered.

This second component affects both the Novelty and Technical Significance criteria as used in the NASA Evaluation Process. The "Novelty" an item possesses may often be related to its particular use or utility, and the "Utility" of an item is still not strictly defined by the NPD 5700.2 definition.

Obviously, an in-depth market study would have to be carried out—prior to publication—to strictly determine whether an item has "demonstrable value and utility" to a segment of the economy other than the aerospace industry. This, of course, is not economically nor practically feasible for the Technology Utilization Program.

Thus, the NASA Evaluation Criteria can and must be used in a "best judgment" sense, without inhibiting the flow of technology which may prove useful to some sector of the economy.

The actual degree of "demonstrable value and utility" can be validly determined only by detailed monitoring and evaluation of the response to NASA publications. Statistical data should show definite technology publications. Statistical data should show definite technology marketplace responses to the varieties of technology NASA makes available. Such statistics and relevant evaluation should provide guidance to the evaluation system via definitive policy statements in a feedback system. Sections 3 and 4 will define the three NASA Criteria for the Evaluation Process, will discuss their use in the Evaluation Process, and will describe in detail the Logical Decision Structure of the Evaluation Process.

3.2 Definition of NASA technology evaluation criteria

3.2.1 Novelty

The criterion of novelty, as used in the NASA Evaluation Process, may be stated simply as:

If an item of science or technology:

a. Is not recognizable in any standard reference, text, or product literature;

b. Has not received widespread publicity among its potential user audience; and

c. Is not, in the opinion of evaluators knowledgeable with items technological components and/or with items applications, a trivial extension of current art or applications,

then publication and dissemination in some format should be considered.

This statement actually defines the minimal acceptable degree of novelty necessary for an item of science or technology to be considered for publication. This statement may be clarified by restating the criterion in terms of more specific questions. Two initial questions which should be considered in the Evaluation Process are:

a. "What *degree of novelty* does an item of science or technology exhibit, when compared with the current state-of-art within the item's sector of technology?"

b. "What *degree of novelty* does an item of science or technology exhibit in terms of its intended secondary, or potential applications to a specific problem or area of study?"

These two questions define the two dimensions of novelty an item generally possesses. The first dimension concerns the item as an entity, somewhat apart from its application or applications. For example, consider an electromechanical transducer. Both dimensions can be considered by asking: (1) "How novel are the physical construction and the operative characteristics of the transducer?" and (2) "Is the intended use of the transducer novel in any respects?"

Note that both initial questions ask for an objective judgment of the *degree of* novelty the utilizable technological information exhibits. The question of degree of novelty leads to a further question for each of the two initial questions; that is, "Has an exact or highly similar item of science or technology been developed, documented, reported, or produced, and has it been utilized for the same or a highly similar purpose?"

This third question essentially asks for a judgment on degree of novelty requiring a "Yes" or "No" answer. Such a judgment can be made on the basis of a review of technical publications, handbooks, textbooks, product literature, etc. Exhibit I (Pages 3–4) illustrates the logic flow of these questions. If an item exhibits no novelty in either dimension, then publication is highly improbable, unless the general audience is unaware of the item and its application (such a case is rare). If an item exhibits some degree of novelty in either dimension, then publication is probable and the item should be evaluated with respect to other criteria. The form of publication used depends on the degree of novelty and significance an item exhibits.

3.2.2 Technical significance

The criterion of technical significance, as used in the NASA Evaluation Process, may be stated as: "An item of science or technological information, exhibiting actual or probable usefulness in a sector of science/technology, or industry, should be considered for publication and dissemination." A number of initial questions become immediately apparent:

a. What is the probable usefulness of the item in its intended or other possible applications?

b. What audience in the industrial or technological sectors, will the item interest?

c. Are there possible secondary uses of the item, either intra- or interdisciplinary?

d. If no immediate uses are apparent, what is the magnitude or significance of the general knowledge the items will add to a sector of science or technology?

e. Will the item serve to stimulate creative thought and innovation if published and disseminated, even if it exhibits no immediate or apparent usage beyond solving specific technical problems?

The NASA Evaluation Process must attempt to answer all these initial questions. Each question, however, involves a judgment on the part of the evaluator, as to the *degree of usefulness* the item exhibits. This judgment affects the recommendation to publish or not publish in much the same fashion as does the judgment of *degree apparent of novelty*. An exception occurs in that an item, possessing no identifiable usage, may still be considered for publication, if it is judged to be stimulating or interesting to the general audience.

ROUGH DRAFT

Exhibit I

"If an item of science or technology:

1. Is not recognizable in any standard reference, text, or product literature;
2. Has not received widespread publicity among its potential user audience;
3. Is not, in the opinion of evaluators, knowledgeable with items technological components and/or with items applications, a trivial extension of current art or applications,

then publication and dissemination in some format should be considered."

Question 1:
What degree of novelty does an item of science or technology exhibit when compared with the current state of-art within the item's sector of technology?

Question 2:
What degree of novelty does an item of science or technology exhibit in terms of its intended, secondary, or potential application to a specific problem or area of study?

Minimal Requirements

Has an exact or highly similar item of science or technology been developed, documented, reported, or produced? Or, is the item a trivial extension of current art?

Has an exact or highly similar item of science or technology been utilized for the same or a highly similar purpose? Or, is the item a trivial extension of current applications?

Possible Range of Answers

(YES)	Item exhibits low degree of novelty in both deminsions: ∴Publication probably not warranted, but check other Criteria.	(YES)	Publication improbable
(YES)	Item exhibits some degree of novelty in terms of its application: ∴Check utility & technical competence and consider publication	(NO)	Publication highly probable
(NO)	Item exhibits a relatively high degree of novelty in terms of prior art and applications: ∴ Check utility & Technical competence and consider publication	(NO)	

ROUGH DRAFT

3.2.3 Technical competence and accuracy

The criterion of technical competence and accuracy, as used in the NASA Evaluation Procedure, presents the following requirements for publication of utilizable technical information:

a. The technical information should be scientifically correct and contain no technical incongruities.

b. The technical information, if describing an item claimed to perform in prescribed fashion, should clearly substantiate that fact if the item has been reduced to practice.

c. The technical information should clearly indicate how effectively an item (as described in requirement 2) functioned in its intended application.

d. The technical information should be carefully reviewed to make sure it does not describe an item which is incompetent, non-effective or trivial attempt at a problem solution.

The first three requirements of this criterion are generally easy to apply, if the documentation of an item has been properly executed. The fourth requirement is more difficult to apply and may involve a judgment of some subjective nature. Thus, any item not recommended for publication solely on the grounds described in requirement four should be carefully reviewed to obtain objective, technical reasons for a negative recommendation.

If an item meets these four requirements, it should be considered for publication and evaluated with respect to the other Criteria. An item may, in terms of requirement three, exhibit certain shortcomings or limitations in its intended application. Such shortcomings are not grounds for a negative publication recommendation if it is felt that the item could be made more effective, if further work is being carried out, or if the item may have other applications.

3.3 Application of the criteria in the evaluation process

The procedural application of these Criteria to the technical information inputs, to be described in detail later in this chapter, must result in a recommendation either for or against publication. And if the recommendation is positive, it must also recommend the mode of publication, i.e., Tech Brief or Compilation. These two recommendations can be made using the Evaluation Criteria.

In order for a piece of utilizable technical information to be published, it *must* meet the Criteria of Technical Competence and Accuracy. If it does meet this Criteria, then the degree to which it fulfills the Criteria of Novelty and Significance will determine whether or not publication is desirable and, if so, the most appropriate mode of publication.

The actual establishment of a separate set of criteria for information to be released via Tech Briefs and information to be released via Compilations is thus quite difficult, since the same Criteria—Novelty and Significance—are used in the evaluation and recommendation process. The decision for or against publication and the mode of publication depends on the pattern of Criteria fulfillment an item exhibits.

Every item of science or technology passing through the NASA Evaluation Process has its own pattern of Criteria fulfillment. That is, each item meets the various requirements making up a Criterion in a different fashion and in differing degrees. Various repetitive patterns have historically developed and are generally used to determine whether or not an item should be published, and the mode of publication to be recommended.

For the purposes of this discussion, these patterns may be illustrated by diagrams showing the evaluated range (or degree) of fulfillment of each requirement for the Novelty and Significance Criteria for some typical item types. These typical patterns represent the most common evaluation results and illustrate 1) the lower limits for publication recommendation and 2) the patterns which lead to Tech Brief or Compilation recommendations. Each diagram represents an evaluation for a mythical, non-identified item of science or technology. Exhibits II through VIII represent commonly observed evaluation patterns for items typically passing through the NASA Evaluation Process. These exhibits do not cover all possible cases of Novelty/Significance evaluation but are representative of the majority of items which have been evaluated in the Technology Utilization System.

EXHIBIT II

Item is commercially available and has been publicized in product literature
Item is thus within current state-of-the-art
Item is used for intended application
Moderate overall significance to be expected if product is marketable
Decision: Do not publish.

EXHIBIT III

Item may be found in standard text or reference and has probably reached its potential audience
Item is thus within current state-of-the-art
Degree of novelty with respect to application is low to moderate
Overall degree of significance is low to moderate
Decision: Do not publish.

EXHIBIT IV

Item has not previously been published, recorded, produced, etc.
Item exhibits low to moderate degrees of novelty in terms of technology and application
Overall degree of significance is low to moderate
Decision: Publish in a compilation.

EXHIBIT V

Same as Exhibit IV, but degree of significance of item is moderate to high
Decision: Publish as a tech brief.

EXHIBIT VI

Item is commercially available (or has been previosuly disclosed to the public)
Item is within current state-of-the-art
Item exhibits high degree of novelty with respect to its application, either intended or secondary
Overall degree of significance is moderate (or high)
Decision: Publish as a tech brief—If it is a new use for a commercially available item, the manufacturer should be notified and the innovation carefully considered for publication as a Tech Brief

EXHIBIT VII

Item is highly novel in terms of technology and application
Item has little or no indentifiable significance to other than those who developed it
Decision: Publish as a tech brief, but carefully consider consequences if item is a "Rube Goldberg" type of innovation

EXHIBIT VIII

Item exhibits moderate to high novelty in terms of technology and application
Item exhibits moderate to high demonstrable utility
Item adds significant knowledge to a field of science or technology
Decision: Publish as a tech brief and consider as a candidate for Technology Utilization Report

SECTION 4. THE NASA EVALUATION PROCESS—LOGICAL DECISION STRUCTURE

4.1 Evaluation process.

The NASA Technology Evaluation Criteria are utilized within a semi-rigid Evaluation Process to achieve an objective evaluation of the merits of an item of science or technology. The actual Evaluation Process, or Logical Decision Structure, is diagrammed in Exhibit IX. The Process consists of three phases of review:

a. Pre-Screening Documentation Review
b. First Level Evaluation—Preliminary Screening
c. Second Level Evaluation—In Depth Review

4.1.1 Pre-screening documentation review

The basic goal of this phase of the Evaluation Process is to determine whether the information content of an item contains sufficient documentation to permit First Level Evaluation. An item submitted for evaluation which has obvious information gaps, i.e., no operational description, or documentation completely missing, is thus immediately screened out of the Evaluation Process. If this action occurs, a Class IV Preliminary Screening Recommendation is generally prepared and submitted to NASA's Technology Utilization Division and the originating NASA Field Center.

Acceptable documentation requirements are set forth, with examples, in NASA Handbook NHB—"Documentation Requirements Handbook". An item not fulfilling these requirements is screened out of the Process, as described above, and should be resubmitted with the required documentation content.

4.1.2 First level evaluation—preliminary screening

The basic goals of the Preliminary Screening Phase of the Evaluation Process are to:

a. Eliminate from the Evaluation Process all items which are recognizable as commercially available, well-known, standard engineering practices, or trivial extensions of current technology.

b. Recheck items for information still missing and probably required for the In-Depth Review.

c. Determine whether an item has been previously submitted for evaluation.

d. Identify any apparent and significant limitations of an item which would inhibit its use in secondary applications.

These goals form the basis for the four major decision blocks of this phase.

The end result of Preliminary Screening is twofold: first, it inhibits most inconsequential, highly limited, previously widely publicized, previously evaluated, or well-known techniques from being processed through the extensive In-Depth Review Phase; and second, it reduces system time lags and costs. The time and skills of the evaluators performing In-Depth evaluations are thus more effectively exercised on those items with higher probabilities of technology transfer and greater probable economic benefits to the nation.

It should be noted that two evaluative checks on the technical limitations of an item are performed during the Evaluation Process. The first is performed during the Preliminary Screening and the second in the Utility Decision Block of the In-Depth Review Phase.

4.1.3 Second level evaluation—in-depth review

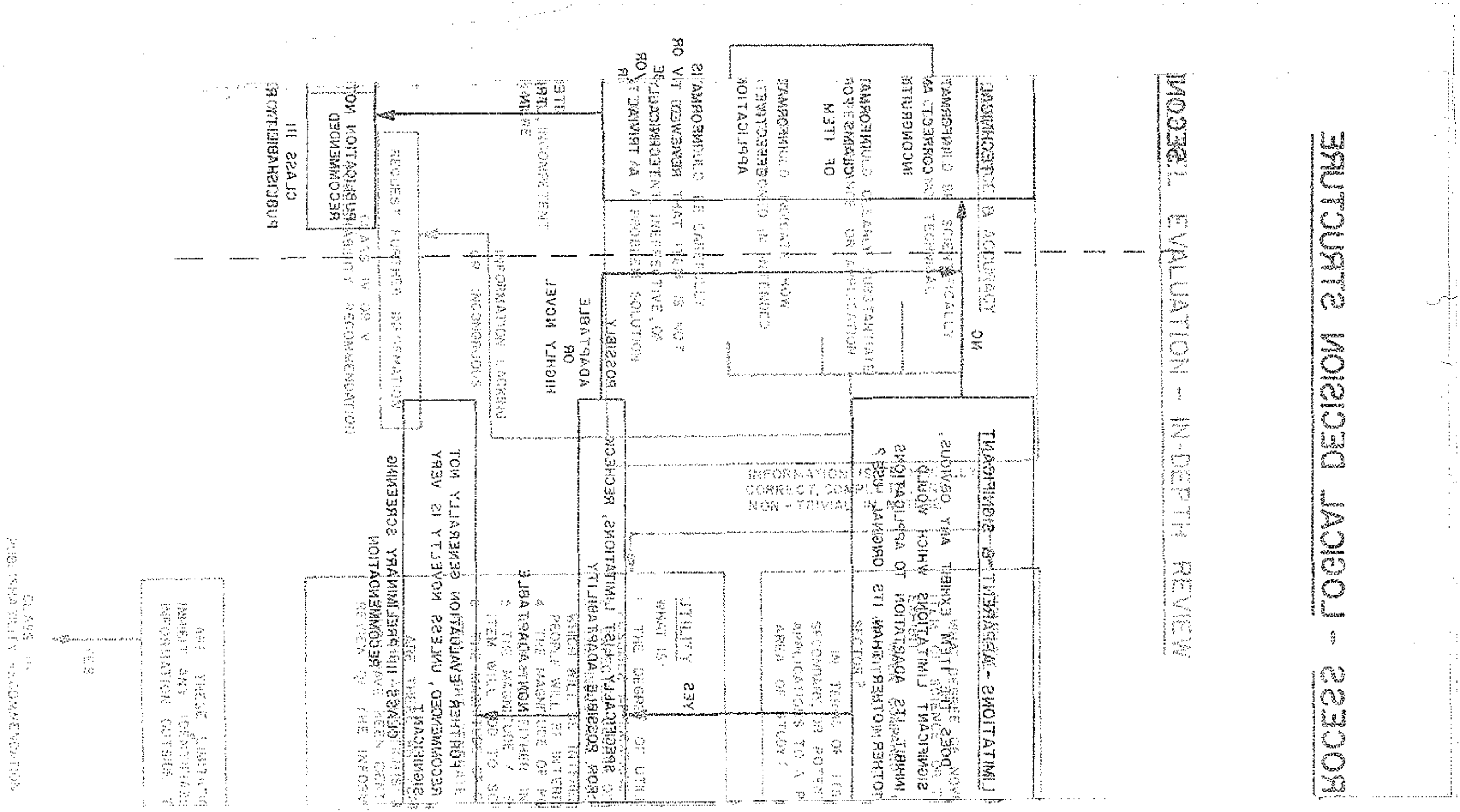
The third Phase of the Evaluation Process is a detailed In-Depth Review of all characteristics of an item. The items reaching this final stage have a high probability of achieving publication, relative to items screened out in the first two phases of the Process. In this Phase, therefore, the basic goals are to:

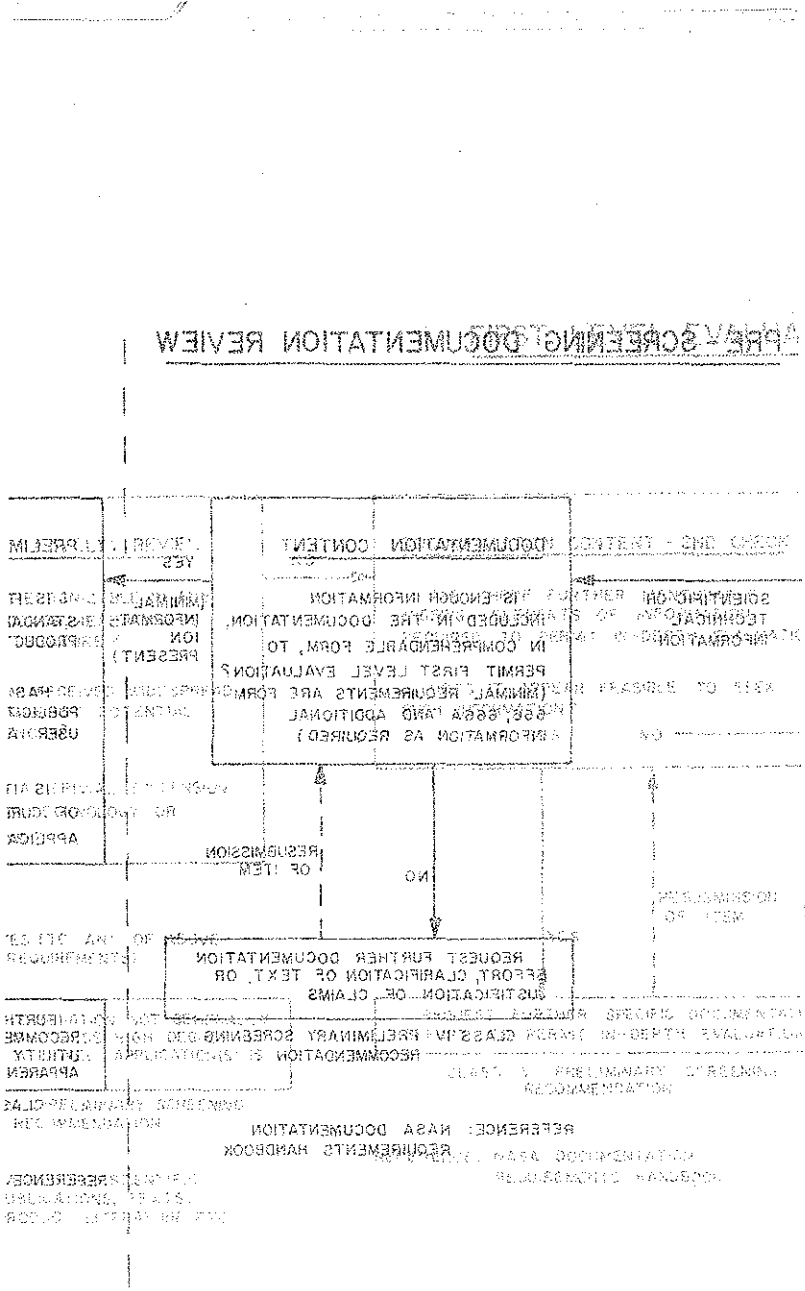
a. Determine whether the information content is technically accurate and that the item can clearly accomplish its claimed purpose.

b. Determine the fulfillment patterns for degree of Novelty and degree of Utility (See Exhibits II to VIII).

One end result of this Phase may be a Recommendation for publication in one of two formats: Tech Brief or Compilation. Another end result may be a negative recommendation based on lack of sufficient Novelty or Utility. A third end result might be a request for information required to substantiate or clarify the fine points of an item's operational ability.

The In-Depth Review Phase of the Evaluation Process produces evaluative judgments of the probability that a particular item will be transferable, the technological sectors of the economy that will find it of interest, and a clear identification of an item's novel features, advantages, and disadvantages. Such information is used to provide direction in the writing of the publication draft in order to further enhance the probability of technology transfer.


SECOND EVALUATION - IN-DEPTH REVIEW
PROCESS - LOGICAL DECISION STRUCTURE


PRE-SCREENING DOCUMENTATION REVIEW
REFERENCE: NASA DOCUMENTATION
REQUIREMENTS HANDBOOK

SECTION 1

EXHIBIT 1

INTRODUCTION

Technology reported by NASA Centers and Contractors through the Technology Utilization Program is screened and evaluated to determine the most efficient method of dissemination. The methods and criteria discussed in this report are those used in making publication decisions for Tech Briefs and Compilations. This report outlines the basic evaluation methods and discusses their application to specific cases. Criteria for selection of individual items are carefully defined and step by step procedures for application to specific cases are described. As considerable judgment as to novelty, significance and technical accuracy of individual reportable items, is required on the part of the evaluator using the criteria, the report can be best applied as a guideline. The use of specific criteria should not restrict or inhibit the creativity of the evaluator. The transfer of technology from one sector of society to another can be best served by an independent, creative and objective recommendation by the evaluator as to the most effective method of dissemination.

EVALUATION PROCEDURES

All computer programs which are produced are not necessarily worthy of being included in a system for dissemination. Some programs which are developed are too limited in function to be of interest to anyone other than the person who wrote the program. Some programs are so common in function that everyone already has the same type program. Some programs are produced which would be of wide use but proper documentation is not prepared to enable potential users to run the program or to understand the exact purpose of the program. For these reasons, an evaluation process is necessary before including the program in the COSMIC system.

The evaluation process involves many operations to enable COSMIC to make proper distribution of computer programs. The major operations are: categorizing by technical classification, checking for complete and usable documentation, identifying the exact use of the program, identifying potential use or value to industry, business, governments, and educational institutions (normally involving an estimation of the number of potential users), selecting means of publication, determining price category of the program. If documentation is not complete, proper action must be taken to insure getting the needed information so that evaluation can be completed.

The initial process in evaluation is to determine if the documentation is sufficient to enable the user to understand specifically what the program is designed to do and to enable the user to set-up and run the program successfully. The following items are considered to be necessary to meet the above requirements: (All items explained in the documentation criteria section).

1. Flash Sheet (See page 63 of this handbook)
2. Description of the program
3. Method of solution
4. Program restrictions
5. Program timing
6. Accuracy of results
7. Operating (Run) instructions
8. Flowchart of program (optional but very useful)
9. Associated reports or documents (optional but very useful).

If the documentation proves to be inadequate, it is classed according to classification IV of the Issuability Classification (Exhibit 2) except when the information which is available indicates the immediate rejection of the program. In this case the program is classified as a class III. If the information indicates that the program is similar to existing programs which the majority of users already have and does not offer significant advantage to warrant its use or that it is intended for very specific purposes and can not be readily adapted to other uses, the program would be rejected according to Issuability Classification III, 1 or 2 (Exhibt 2).

Exhibit 2 contains the Issuability Classification Definitions. These are guidelines followed by the evaluator for classification of program documentation. Exhibit 3 contains an interpretation of the Issuability Classification Definitions listed in Exhibit 2 and has been presented to acquaint Technology Utilization Officers, New Technology Engineers, and contractor personnel with the guidelines by which a program is evaluated and classified.

If the documentation is adequate, identification of the process and use are then undertaken. These steps are necessary to determine whether the program is of sufficient use as it is or if it contains possible functions which can be easily altered to broaden its use if the user so desires. This is an important part of the evaluation since many programs would be of restricted use if they could not be easily altered. Changes in the programs are not performed by COSMIC. The only interest in such alterations is to enable the user to get more from the program than that for which it was originally written.

Involved in all phases of the evaluation to this point has been an attempt to identify the potential use for a program. In performing this function, COSMIC attempts to identify the types of industry business, government, and education and in some cases, the particular users who will be interested in the program. If a program proves, in this phase of the evaluation, to be too narrow or too general, as specified above, it will be categorized as Issuability Classification III, 1 or 2. If it is of significant use, it will be evaluated further.

The next action, once a program is accepted, is to determine its means of publication and produce the needed information (an abstract or drafted Tech Brief) for publication. Publication is one of three forms:

1. Multiple Technical Publication
2. Tech Brief
3. Compilation

A multipage technical publication is recommended when a computer program is likely to be of widespread interest and is likely to have a noticeable impact on either the computer industry or on the industry with which the program deals. The effect of the program will probably be in greatly simplifying a task or in setting increased performance and for lower cost standards. The information in the publication will describe the technique employed in the program and will survey the state-of-the-art at that class of program.

A Tech Brief is recommended for a program which is likely to be of interest or use to a significant group of users and will probably lead to improvements in programs or programming techniques, but will not have a significant effect on its industry. The Tech Brief, which will be drafted by COSMIC and published by NASA, will consist of a detailed abstract, and will not exceed two typewritten pages including any necessary art work.

Programs which are likely to be of interest or use to specific industries or businesses, but which do not warrant Tech Briefs, will be recommended for inclusion in compilations. A compilation will consist of abstracts and related information (such as program language and equipment required) of approximately 20 programs. Where possible, all of the programs in a Compilation will be of the same technical nature or classification. COSMIC will prepare the abstracts for the Compilation and NASA will assemble and publish the Compilation.

If documentation is determined to be inadequate and further information is requested, the available documentation is filed until more information is received, at which time the entire process is repeated since all original conditions apply not only to the additional information but also to the package consisting of the original plus the additional information.

After each evaluation is completed, an Issuability Report (Exhibit 4) is prepared by the evaluator, and copies are sent to TU Headquarters, to the TU field office that forwarded the program to COSMIC, and to the Contracting Officers Representative at MSFC.

Should a program receive a Class IV, a list of missing information is attached to the Issuability Report form by the evaluator (Exhibit 5). The information which is missing from the original Flash Sheet Package is indicated on this sheet to assist the program originator in providing a more comprehensive documentation of his program. Exhibit 6 contains a completed Issuability Report (Issuability Report—Exhibit 4) indicating that inadequate documentation has been submitted with the Flash Sheet Package. Exhibit 7 contains a completed Information Required form (Exhibit 5) relating to the Issuability Report (Exhibit 6) and indicating the areas where information is lacking. Exhibit 8 contains an Issuability Report on a program which has been evaluated and classified as

a Class II program. This program has been recommended for publication in a Compilation.

The Documentation Criteria section and the Evaluation Procedure section and the accompanying exhibits have been provided to acquaint field personnel with areas of information both required and desired by COSMIC to make up a properly documented package and the procedures followed by COSMIC in evaluating, classifying, and recommending for publication a noteworthy program. It is hoped that this information will provide a better understanding of COSMIC's methods and problems and promote a better working relationship between all agencies involved in the entire project.

EXHIBIT 2

STATEMENT OF ISSUABILITY CLASSIFICATION DEFINITIONS (APPLIED SPECIFICALLY TO COMPUTER PROGRAMS)

I. This computer program solves a technical problem which has sufficient interest to warrant publication of a Tech Brief describing the program.

1. Additionally, this program is significant enough to warrant further evaluation for possible publication of a multi-page Technology Utilization report.

2. However, it is not significant enough to warrant further evaluation.

II. This computer program solves a routine data-processing or mathematical problem and, as such, should be published in a TU Note (Compilation) along with similar programs. This item does not warrant further publication.

(Technical category numbers will be used to determine proper Compilation classification)

III. This computer program should not be published through the TU program because:

1. It is similar to existing programs and does not offer sufficient advantages to warrant its use.

2. This program is intended for a very specific purpose and could not be readily adapted to other uses. As such, it will have limited interest to industry.

IV. More information is needed to determine whether this program may be of interest or use.

EXHIBIT 3

INTERPRETATION OF ISSUABILITY CLASSIFICATIONS (APPLIED SPECIFICALLY TO COMPUTER PROGRAMS)

I. (1) This computer program should probably be of widespread intrest. It is likely to have a noticeable impact on either the computer industry or on the industry with which the program deals. It will probably effect the industry by greatly simplifying a task or by setting new performance and cost standards. This type of program will probably warrant a multi-page publication which either describes the new techniques employed in the program or which surveys the state-of-the-art of that class of programs.

(2) This program is likely to be of interest or use to a significant group and warrants publication as a Tech Brief. It will probably lead to improvements in programs or programming techniques, but will not have a significant effect on its industry. Publication of a Tech Brief and subsequent dissemination through the COSMIC program duplication service will be sufficient dissemination.

II. These programs solve routine problems in mathematics and data-processing and will probably only be of interest to smaller computer installations which do not have complete systems libraries. Dissemination of these programs will probably be best accomplished by including them in a compilation of similar programs.

III. This program should not be publicized through the Technology Utilization Program for the following reasons:

(1) This program is similar to programs which are readily available at all installations where they are needed. It offers no significant advantages to warrant its adoption.

(2) This program could not be readily adapted to uses other than those for which the program was intended. As the intended use is for a very specific task which does not have any recognizable industrial counterpart, this program will be of little interest to industry.

IV. No determination of the classification of this program can be made until certain specific information is presented. The required information should be detailed on the Publishability Report. If the originating agency can not supply the required additional information, this program should not be published.

EXHIBIT 4

ISSUABILITY REPORT

REPORTABLE ITEM NO. (A): ☐☐☐☐☐☐☐☐ (4-12) ☐☐☐☐☐ (S)

PUBLISHABILITY CLASS (K) ☐ (13-15)

TECHNICAL CATEGORIES

PRIME (V) ☐☐☐

SECONDARY (VV) ☐☐☐

TITLE OF INNOVATION:

This innovation was evaluated to determine whether it might be of sufficient use or interest to some sector of the economy to warrant active dissemination of information about it through the NASA Technology Utilization Program.

Recommendation:

Reasons for Recommendation:

☐ Send Source Deck to COSMIC

☐ COSMIC presently has Source Deck

COSMIC

C O S (D)

(31-33)

EXHIBIT 5

INFORMATION NEEDED FOR EVALUATION

_____* Flash Sheet

_____* Program Language

_____* Computer (machine) Requirements

_____* Description of Program

_____* Method of Solution

_____* Operating (run) instructions

_____ Program Restrictions

_____ Program Timing

_____ Accuracy of Results

_____ Flowchart of Program

_____ Listing of Program

* These items are required - the others are desirable.

EXHIBIT 6

Form No. 260B

ISSUABILITY REPORT

Reportable Item No. (A): MFS-13216P Date: Mo. Day Year 07 27 67

Publishability Class (K): IV ( ) Technical Category (V): 6G3 (VV):

Contractor: North American Aviation

NAR 50665

Title of Innovation: Statically Determinate, Six Member, Support System Analysis

This innovation was evaluated to determine whether it might be of sufficient use or interest in industrial applications to warrant active dissemination of information about it through the NASA Technology Utilization Program.

Recommendation: It is recommended that this program not be published at this time.

Reasons for Recommendation: This program is used to compute axial forces, torques, deflections, and rotations for a stable, statically determinate, six-member mount. The program has been principally used for the analysis of turbopump support structures. It is quite general and can be applied to any structure modeled as a rigid body and supported by a statically determinate mount structure.

However, the material presented is insufficient for evaluation. The information needed before publishing the program in a compilation with other similar programs includes the information marked on the attached sheet.

EXHIBIT 7

INFORMATION NEEDED FOR EVALUATION

_____ * Flash Sheet

_____ * Program Language

_X_ * Computer (machine) Requirements

_____ * Description of Program

_X_ * Method of Solution

_X_ * Operating (run) instructions

_____ Program Restrictions

_____ Program Timing

_____ Accuracy of Results

_____ Flowchart of Program

_____ Listing of Program

* These items are required - the others are desirable.

EXHIBIT 8

Form No. 260B

ISSUABILITY REPORT

Reportable Item No. (A): MSC-11191-F

Date: Mo. Day Year 07 13 67

Publishability Class (K): II ( )

Technical Category (V): 6D1
(VV):

Contractor: North American Aviation

SID 56514

Title of Innovation: Multiphase Chemical Equilibrium Composition

This innovation was evaluated to determine whether it might be of sufficient use or interest in industrial applications to warrant active dissemination of information about it through NASA Technology Utilization program.

Recommendation: It is recommended that this innovation be published in a compilation.

Reasons for Recommendation: This computer program uses the RAND method of free energy minimization for computing the equilibrium composition of a multiphase system. It was written specifically for treating the equilibrium composition of an inorganic reinforced plastic under heating conditions. However, any system consisting of the 80 gaseous and 15 condensed species covering the 12 elements considered in this program may be analyzed. With modifications in the stored data other systems may be analyzed. This program would be useful to the checmical industry. It is recommended that this innovation be published in a compilation with other similar programs.

GLOSSARY OF TERMS

COSMIC	Computer Software Management Information Center.
F S	Flash Sheet - Form initiated by NASA Field Center describing program documentation.
MACHINE	Hardware component portion of an operating system.
NMI	
NTE	New Technology Engineer - A NASA representative located in a contractor area.
IR	Issuability Report - The report originated by the COSMIC evaluator outlining the merits or shortcomings of a program.
SOFTWARE	The program package consisting of the documentation and the source deck.
SOURCE DECK	The punched card deck or magnetic tape containing the program and any subroutines associated with the program, in such form to make it readily usable with the designated operating system/s.
STID	Scientific and Technical Information Division.
STIF	Scientific and Technical Information Facility operated by Documentation Incorporated for STID.
SYSTEM	The operating system for the program as specified in the documentation.

86-578—67——10

TSP	Technical Support Package - The complete program package issued by the Technology Utilization Division to requesting users. Consists of the program documentation and source deck.
TUC	Technology Utilization Center - In this case COSMIC. The university or institute assigned the responsibility for evaluating and recommending the publication of meritorious programs.
TUD	Technology Utilization Division - The NASA headquarters for the Technology Utilization Program.
TUO	Technology Utilization Officer - The NASA representative at the Field Center whose responsibility along with the NTE is the proper identification and documentation of new technology.
TUP	Technology Utilization Program - The program created by NASA for compiling, identifying, and disseminating new technology to non-aerospace areas of government, education, business, and industry.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
Washington, D.C., November 8, 1967.

Hon. JENNINGS RANDOLPH,
Select Committee on Small Business,
U.S. Senate, Washington, D.C.

DEAR SENATOR RANDOLPH: This is to complete the answers to the questions posed in your October 2 letter, all but one of which I answered in my letter to you of October 24.

The remaining question deals with specification of the characteristics of those who inquire for additional information about NASA technology announced to industry via Tech Briefs. As I noted in my October 24 letter, a thorough analysis is underway but the only data available to date deals with company size and geographical location.

Of total inquiries, 53 percent come from small companies, 36 percent from large companies, and 11 percent from individuals not giving their institutional affiliation. Of the 10,328 inquiries responded to during the first nine months of 1967, the geographical locations of the inquirers are as follows:

Alabama	120	Iowa	66
Alaska	4	Kansas	34
Arizona	56	Kentucky	42
Arkansas	12	Louisiana	71
California	1,426	Maine	8
Colorado	107	Maryland	297
Connecticut	262	Massachusetts	514
Delaware	31	Michigan	394
District of Columbia	107	Minnesota	159
Florida	141	Mississippi	17
Georgia	60	Missouri	212
Hawaii	11	Montana	8
Idaho	25	Nebraska	24
Illinois	747	Nevada	6
Indiana	293	New Hampshire	56

New Jersey	519	Tennessee	95
New Mexico	99	Texas	375
New York	1,179	Utah	37
North Carolina	76	Vermont	12
North Dakota	3	Virginia	153
Ohio	949	Washington	134
Oklahoma	82	West Virginia	41
Oregon	59	Wisconsin	257
Pennsylvania	883	Wyoming	6
Rhode Island	21		
South Carolina	32	Total	10,328
South Dakota	6		

We appreciate your interest in the progress of the NASA technology utilization program.

Sincerely yours,

RICHARD L. LESHER,
Assistant Administrator for Technology Utilization.

Senator NELSON. Our next witness is Mr. Edward J. Brunenkant, Director of the Division of Technical Information, Atomic Energy Commission.

If you will identify for the record your associates.

STATEMENT OF EDWARD J. BRUNENKANT, DIRECTOR, DIVISION OF TECHNICAL INFORMATION, ATOMIC ENERGY COMMISSION, WASHINGTON, D.C.; ACCOMPANIED BY JOHN REICH, ASSISTANT GENERAL COUNSEL, RESEARCH AND DEVELOPMENT; AND WALTER A. KEE, TECHNOLOGY UTILIZATION OFFICER

Mr. BRUNENKANT. Yes, I will, Mr. Chairman. On my right is Mr. Reich, our Assistant General Counsel. And on my left is Mr. Walter Kee, who runs for my Department our technology utilization program.

Senator NELSON. I regret our limitations of time.

You may read your statement or present it in any fashion you see fit. You may extemporize from it.

Mr. BRUNENKANT. I would be pleased to do anything the Chairman would like.

Senator NELSON. Whatever you prefer.

I have about 25 minutes.

Mr. BRUNENKANT. All right, sir. The statement is short. At the end of the statement we will be pleased to answer any questions that the chairman or members of the committee have.

Senator NELSON. I think we will have to do as we did previously—submit staff questions subsequent to your testimony and based upon it in order to fill out the record here.

Mr. BRUNENKANT. We will be pleased to do that, sir.[1]

I am very pleased to appear before your subcommittee to discuss the Atomic Energy Commission's views and experience in the field of technology transfer. As you know, Chairman Seaborg is presently in Europe attending the General Conference of the International Atomic Energy Agency and is unable to appear before you today.

The AEC is required by its enabling legislation to develop, use, and control atomic energy so as to make the maximum contribution to the general welfare. The Commission has interpreted this require-

[1] See p. 147.

ment to mean that it actively encourages the industrial use of the nuclear technology resulting from its research and development programs. We have had some noteworthy successes. Everyone is familiar, for example, with the reactor development program, a multibillion-dollar effort which has had a major impact on the electric utility industry and is likely to play an important role in the development of plants for desalting of sea water.

The applications of radioisotopes and radiation present another large area where AEC-developed technology seems likely to have important industrial effects, for example, in the preservation of food and the production of plastic-impregnated wood.

The Commission's policy has been to encourage and assist the development of a self-sustaining commercial nuclear industry. It has helped commercial firms develop the capability for manufacturing nuclear reactors, nuclear instruments, fuel elements, and other nuclear related items, for producing and using stable isotopes, for reprocessing reactor fuels and for providing various supporting nuclear services. It has, itself, consistently withdrawn from the production of nuclear products and services whenever it was clear that they could be provided effectively and economically by private enterprise.

The actions and policies thus far noted have spurred the growth of a private nuclear industry. We are aware also that in the conduct of AEC-sponsored research and development, numerous innovations are made in processes, materials, equipment, and techniques which have wide potential usefulness in nonnuclear industry. We have always encouraged the transfer of this technology.

In the past few years, we have put special emphasis on this objective through a program specifically designed to ferret out, publicize, and facilitate the transfer to industry of the most promising nonnuclear innovations. The program is centered in Offices of Industrial Cooperation at major AEC laboratories which serve as focal points for contacts between industry representatives and scientists and engineers of the laboratories. Such contacts are made by face-to-face meetings, by laboratory tours and conferences, and by the dissemination of business-oriented summaries, drawings, and other engineering materials.

The Commission also has authorized its contractors to provide consulting services and to make AEC facilities available for private work on a cost-reimbursable basis when they are not available commercially.

The AEC also participates in conferences along with such agencies as NASA, SBA, and OSTS in order to make industry aware of the Government's efforts to transfer technology.

While we believe that our program and those of other agencies are moving in the right direction, we are aware that there are formidable problems to be solved before an effective technology transfer system can be developed. Hearings such as these should be useful in clarifying the issues.

One issue which has been raised is whether it would be wise to centralize all Federal technology transfer activities in a single agency. It has been our experience that the fewer filters we interpose between the innovator and the potential user, the better the chance of effective communication.

We feel that the direct contact between innovator and user is not only the most effective transfer mechanism, but that it operates at less cost both to the Government and to industry. In addition, where there is direct contact, a two-way transfer of technical information may occur which can be of substantial benefit to the Government agency as well as to industry. Also, we believe that the use of a central agency would inhibit the experimentation with transfer mechanisms now being carried on by various agencies.

At this early stage in the development of the methodology of technology transfer, such experimentation should be sustained in order to identify the more effective mechanisms.

Until now, most Federal technology transfer programs have operated on the basis that, after the Federal agency does its best to publicize available technology, the initiative for determining its suitability, making necessary contacts, and taking steps to utilize the technology must rest with the industrial user. We believe that more actual transfers might occur if the innovating Government agency were to take active steps to seek out potential users.

A recent example of AEC spinoff is worth mentioning at this point. Since 1963, the AEC and the National Cancer Institute of the National Institutes of Health have been working together to develop liquid centrifuges for use in studying the role of viruses in the production of human cancer.

In conjunction with this program with NIH sponsorship, AEC is developing advanced models to produce purified vaccines on a large-scale basis. Now the Oak Ridge facilities, again at NIH's request are fabricating about 18 of the current generations of the centrifuges, which cost about $40,000 each to produce, for use by the pharmaceutical industry. NIH will select the companies to receive the prototypes and these companies will reimburse the AEC for the cost of producing the units.

A demonstration will be held in October to make industry aware of the capabilities of the equipment and to interest instrument companies in considering the potentialities of producing the centrifuges commercially. The decisions to fabricate the centrifuges, to hold the demonstration and to make the usual dissemination of data were predicated on AEC's belief that this step was necessary in order to effectuate a meaningful transfer of knowledge that may be valuably used for nonnuclear purposes. We submit that such an approach is needed if the maximum transfers of potentially beneficial innovations are to succeed.

Mr. Chairman, this concludes my statement. I thank you for the opportunity to present it.

Senator NELSON. Thank you.

On page 4, the last sentence, you state, "We believe that more actual transfers might occur if the innovating Government agency were to take active steps to seek out potential users." In addition to the dissemination centers, what active steps do you suggest?

Mr. BRUNENKANT. Well, in this particular case we actually constructed a prototype model, which gave people an opportunity to see how it worked, to assess what the manufacturing requirements might be.

Senator NELSON. You are talking about the $40,000 centrifuge?

Mr. BRUNENKANT. Yes, I am.

Senator NELSON. What we are concerned about especially in this committee is the small business problem. We are not interested in the big business problem. But the role of the committee is to be concerned about small business problems.

What ideas do you have for bringing the information out to the small businessmen, in addition to the dissemination centers—all of which I think are fine. It is very interesting, and I hope it will be a successful program.

I still do not see how the small businessman, a hundred, 200, or even 500 employees, is going to tool up to utilize this information. He might even be able to afford it, but not believe that he can, or he might not be able to afford it. And surely those smaller ones just cannot afford it.

What are we going to do to get this information out to them?

Mr. BRUNENKANT. Mr. Chairman, I listened carefully while you posed a somewhat similar question to the NASA representative, and I believe—I think it is a very difficult question to answer in terms of how does our Government keep small business technologically competitive with companies that have scientific and technical wealth at their easy disposal. I wish I knew the answer to that question. Certainly in terms of our consulting services, we do not attempt to distinguish between the large companies and the small companies.

Senator NELSON. I think you are probably going to have to. It seems to me we have got to build something into this dissemination machinery that does for the small businessman what the big businessman can do for himself.

All of the work that is done—and it is very good work—tremendous scientific developments coming about as a consequence of the work of the Atomic Energy Commission, NASA, Defense Department, NIH. In fact, I think about 75 percent of all of the graduate work done in the universities of America is now paid for by the Federal Government. Seventy percent of all the health research in America is paid for by the Federal Government. A major portion, most of the R. & D. in this country is paid for by the Federal Government. We are all taxpayers. But really, the only people who can use it with any planned organized fashion are the people who have got enough money, enough personnel, enough to hire the skills to utilize the wonderful information that the Government produces.

The small businessman is really quite helpless—as much as he would like to use it, he cannot do it.

So why can't we really do more in this field.

It was mentioned in the first testimony what an amazing job of bringing technology on agricultural production the Agriculture Department has done. We started over a hundred years ago with the land grant colleges. We tackled the question of production. We put a home agent and a county agent in every single county in America who went right to the farmer, right to his home. Research was done on the production of hybrid corn, milk production, cattle, beef, everything you can imagine, right in the university. Then they took it right out to the farm, and showed the farmer himself how to use it, because there was

not any way for that farmer to utilize this information, unless it was brought to him. He could not afford the time.

My question is, shouldn't we address ourselves to the question now of bringing right to this businessman, as a final step, the fruits of the information that his government is developing?

I think if you looked at the tax returns in this country, you would find out that the little fellow, whether he is in business or not, is the one who is furnishing most of the money for the research that we are doing. And when the big industry says they are, I would like to remind them that all the taxes they pay are paid for by the consumer, because that is included in the cost of the product.

So I would think that it would be very useful if some of the talented people in the Atomic Energy Commission, NASA, and Defense get together on a joint basis and say "Now, how can we get this material out in the same way that the Agriculture Department brought their information to the little farmers of America?"

Mr. BRUNENKANT. Speaking for the AEC, we will most certainly get together with our counterparts in NASA and DOD and see what we can come up with. I certainly am wholeheartedly in support of your statement. I would like to add it is not, however, in my view only information, the dissemination of information, that stands in the way of effective technology utilization. Quite frequently there are just the formal problems associated with any business. If you already have a heavy capitalization—can you afford to change to a better technique of welding, and so on. These are very real problems, I believe, that exist in technology transfers.

Senator NELSON. I realize it is not a simple problem. I think the steps we are taking are very creative. We are in the experimental stage. I think it is a marvelous thing to get the dissemination centers out, and to get the universities participating with industry.

My only concern is to be sure that we do as much as we can to afford the opportunity to that small businessman who does have the imagination and talent to use the information if it is gotten to him. If he does not have that imagination and talent, it is not going to do him any good whether he is a little business or a big business.

Thank you very much. I am sorry we have to rush along. I think your information is valuable. I am sure the chairman of the committee will appreciate it if you did address yourself to the problem we are talking about, because you have more information about how this problem technically, physically, mechanically, might be tackled than our committee does.

(The supplemental information submitted by Mr. Brunenkant follows:)

U.S. ATOMIC ENERGY COMMISSION,
Washington, D.C., October 18, 1967.

HON. JENNINGS RANDOLPH,
Chairman, Subcommittee on Science and Technology, Select Committee on Small Business, U.S. Senate.

DEAR SENATOR RANDOLPH: I am happy to supply herewith answers to the questions in your letter of October 2, supplementing the testimony which I had the pleasure of presenting to your subcommittee on September 27.

1. How many technical documents result each year from AEC funded scientific R & D? What percentage are classified? What percentage are otherwise restricted from release to the clearinghouse or NASA dissemination programs? On what basis?

During fiscal year 1967, the AEC's Division of Technical Information processed some 13,000 documents which reported on research and development funded by AEC. About 6 percent of these were classified. Of the unclassified documents, about 95 percent were made publicly available through the Clearinghouse for Scientific and Technical Information, the Superintendent of Documents, and the open literature. All of these are, of course, also available to the NASA and other Federal agency programs.

The 5 percent of unclassified documents not publicly distributed, some 370 documents, consisted about 50 percent of documents which, in our own judgment, were not of sufficient importance to warrant such distribution and about 50 percent of documents withheld from distribution at the request of authors because they were prepared for administrative or internal purposes or because they recorded unverified or preliminary findings.

2. Does the AEC plan to establish offices of industrial cooperation at all of its major contractor operated facilities? Discuss the pros and cons of doing this dissemination mechanism versus turning over the data to NASA or the Department of Commerce. Would such OIC's operate regionally or nationally? Would they handle all AEC information or only that identified from their own laboratory?

Offices of Industrial Cooperation are planned now only for four contractor sites. There are offices now at Argonne National Laboratory, Oak Ridge National Laboratory and Sandia Corporation. The fourth one is planned for Pacific Northwest Laboratories, Richland, Washington. On the basis of experience with these four, we will determine whether offices should be established at additional sites.

We believe that technology transfer is accomplished best by having direct contact between the innovating scientist or engineer and the interested industrial organization. Accordingly, we feel that interposing additional filters between the innovator and the potential user, as would be involved if dissemination of AEC-developed technology were entrusted entirely to NASA or Commerce, would materially decrease the likelihood of effectuating the most effective transfer.

We do intend to publicize the most promising innovations through a variety of mechanisms, including the AEC-NASA Tech Brief system, the NASA dissemination centers and the state-designated agencies under the Office of State Technical Services program. Once interest is aroused by any of the mechanisms, we think it most desirable that direct contact between the potential user and the technology source be facilitated.

Each Office of Industrial Cooperation will have contacts with industry throughout the United States but will be responsible primarily for transferring the technology developed at its own site.

3. Discuss the concept of adapting selected new technical ideas by further government funded development so that they could be more easily transferred from their AEC purpose to civilian technology. Do you have such authority now?

AEC's experience in the development of nuclear technology, particularly in the civilian electric power program, has shown that industry is most likely to pick up an idea for commercial exploitation when its feasibility and practicability, from technical and economic standpoints, have been demonstrated. From a statutory viewpoint, AEC is able and has found it programmatically advantageous, to conduct certain R & D efforts through a prototype stage. However, the scope of AEC's programs is, statutorily, essentially limited to atomic or nuclear fields. This does not preclude AEC from disseminating data and otherwise transferring knowledge acquired from its nuclear activities for possible use in non-nuclear areas; also, we believe that minor incidental developing or other efforts by AEC in order to effect the transfer of information for non-nuclear beneficial use would be legally permissible. However, extensive research and development work for non-nuclear purposes would, in our judgment, require additional statutory authorization. It seems to us that the concept you suggest for discussion is worth exploring along these lines: (i) placement of authority in a central agency, concerned with preservation and enhancement of small business interests, to determine which technology items acquired by Federal agencies in the course of their programmatic missions should be developed further for use by small business; and (ii) the obtainment by the mission agencies, where necessary, of additional statutory authority, and the conduct by such agencies of additional R & D work, for non-mission purposes to the extent requested by the central Federal agency mentioned in (i) and concurred in by the mission agency from the standpoint of non-interference with its basic programs.

Sincerely yours,

EDWARD J. BRUNENKANT,
Director, Division of Technical Information.

Senator NELSON. Mr. Rodney Nichols, Office of the Director of Defense, Research and Engineering.

STATEMENT OF DR. DONALD M. MacARTHUR, DEPUTY DIRECTOR, RESEARCH AND TECHNOLOGY, OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING, DEPARTMENT OF DEFENSE, WASHINGTON, D.C.; PRESENTED BY RODNEY W. NICHOLS, OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING; ACCOMPANIED BY WALTER C. CHRISTENSEN, ACTING DIRECTOR OF TECHNICAL INFORMATION

Mr. NICHOLS. Senator Nelson, I would like to say Dr. MacArthur is very regretful he cannot be here this morning. He is extremely interested in this subject. He is in the hospital having a series of tests. He called me this morning and asked me to pass on to you his regrets that he could not be here. I would also like to introduce Mr. Walter Christensen on my left, who is the Acting Director of Technical Information in the Defense Department.

Senator NELSON. Thank you very much.

You may proceeed to present your statement.

Mr. NICHOLS. I have a short statement.

Senator NELSON. You may read your full statement, or, if you prefer, summarize it. If summarized, the full statement will be placed in the record at the end of your appearance.

Mr. NICHOLS. Senator Nelson, we are pleased to have this opportunity to discuss technology transfer. We are aware that your subcommittee has published an excellent report entitled "Policy Planning for Technology Transfer" which carefully highlights all of the critical issues. Thus, my presentation will assess mainly the experience and perspective of the Department of Defense in transferring defense technology to the private sector.

The Department recognizes the importance of making our technology available to anybody who needs it, within limitations imposed by national security. As the subcommittee knows, many major Defense technologies—such as aircraft, electronics, computers and communications—have been transferred to the private sector. But we recognize that the subcommittee is more interested in the broader aspects of technology transfer. So I will try to sketch the general framework of our view of the transfer process.

TECHNOLOGY TRANSFER MYTHS

There are certain aspects of technology transfer which sometimes are not clearly understood. There are, in fact, some myths that we would like to try to expose. The first myth is that most Defense technology is marketable in the private sector. Though a great deal of Defense technology is "technically" applicable to the private sector, much of it is not marketable. Why? Because defense requirements for high performance often lead to a high-cost technology that is not immediately compatible with the economic factors of the private sector.

The second myth is that Defense technology can be used directly in

the private sector. But in practice, seldom can you fully transfer technology without cost. The cost of bringing new ideas to the market is great—estimated at 85 to 90 percent of the cost involved in the overall innovative process. Yet people do frequently make the incorrect assumption that once usable technology is identified by the private sector, it immediately becomes marketable.

A third myth is that technology transfer will increase through additional Government efforts alone. This greatly underrates the importance of the user in the technology transfer process. Government programs to make information on technology available is a "push" part of the transfer. However, potential users must be able and willing to take this technology and apply it—this is the "pull" part. No matter how much governmental "push" action, the efficiency of transfer is limited by the amount of "pull" exercised by careful users.

CHARACTERISTICS OF POTENTIAL TECHNOLOGY USERS

In considering the processes through which technology can be transferred, it is important to recognize the different characteristics of potential recipients. For convenience, these users can be characterized as:

(1) prime defense contractors which have a research and development capability;

(2) non-defense companies which have research and development capabilities; and

(3) companies that do not have research and development capability.

This last group of companies, including many small businesses, is of particular concern from a technology transfer point of view.

CATEGORIES OF TECHNOLOGY FOR TRANSFER

We can also distinguish three general categories of technology which might be transferred—

(1) total systems—communications satellites, aircraft engines, radars;

(2) components and materials—transistors, aluminum; and

(3) techniques, processes and concepts—welding techniques, numerically controlled machine tools, plasma plating, system engineering.

Transfers within the first two categories—systems, components and materials—are comparatively straightforward, and are largely controlled by economic factors. But transfers of techniques, processes and concepts are much more complex, less well understood, and clearly dependent upon special skills of the recipient.

CATEGORIES OF TRANSFERABLE TECHNOLOGY AS RELATED TO USER CHARACTERISTICS

Examples of transferred total systems and devices such as aircraft engines, satellite communication, and weather radar are well recognized. The commercial applications of these technologies are generally obvious and the timing of the transfer is a function of the level

of market demands. The exploitation of such systems in the private sector has been carried out by larger companies with strong research and development capabilities. Smaller companies were generally employed only in a subcontracting role.

The transfer of the second category of technology—components and materials—is also fairly straightforward. Information on Defense components and materials is readily available to those who desire to exploit them in the private sector. Most manufacturers that develop and produce new components and materials for the Department of Defense also serve the civilian market. Advances in components and materials normally are well publicized in trade journals and other technical media. An example was the publication and wide distribution of detailed utilization handbooks on transistors shortly after their development.

Therefore, we conclude that the limiting factors in these first two categories of technology transfer are economic. And these factors may be significantly influenced by defense utilization. For example, few recent technological advances have had as great an impact on an industry as did the transistor. The transistor was an industrial invention, and from the time that it was first demonstrated, its performance advantages over the vacuum tube were evident.

Senator NELSON. What do you mean by industrial invention?

Mr. NICHOLS. I believe it originated outside a Government in-house laboratory. It was not invented through a Government contract but by industry. I think it was originally out of corporate funds in the Bell Laboratory. What we are saying here is——

Senator NELSON. First you said you thought out of Federal research funds, and now you say out of private funds.

Mr. NICHOLS. No, out of private funds. There were Federal R. & D. funds going into the laboratory in which this was invented. This is how the Federal Government became immediately aware of it. But I believe, in fact, the development itself was from corporate funds.

The new device was more rugged, consumed less power, promised greater life, and was much smaller. But it was also far more expensive—as much as 10 to 15 times more expensive than the equivalent vacuum tube. Until the military market, in which performance was far more important than price, demanded enough transistors so that mass production techniques—and the corresponding unit cost reductions—became economically feasible, the transistor was not attractive to the home entertainment electronic industry.

To cite another contemporary example of this economic force, the exploitation of integrated circuits in the private sector is today at the stage that transistors were 10 to 15 years ago. The cost of integrated circuits is not yet fully competitive with discrete components.

In the materials field, aluminum provides another excellent historical example. Until the military requirements for a strong, lightweight material led to marked price reductions to the cost of aluminum, there was little commercial interest in this material. But after the DOD sponsored a buildup of aluminum production capability, costs were reduced, and it was practical for houseware, wrapping, and packaging manufacturers to exploit this new technology.

A most important point relevant to the transfer of technology in components and materials is that exploitation can be accomplished most

effectively by companies having a research and development capability. Even companies without research and development capabilities are able to capitalize on some of this technology after its initial exploitation, though there will be, in general, a greater timelag.

The transfer of techniques, processes, and concepts is the most difficult, both from the Government and the recipient point of view. In addition to economic factors, the exploitation of new techniques and processes is controlled to a great extent by the technical understanding, artistry, and skill of the recipient's staff. In particular, the availability of written information about the technology is a necessary, but not a sufficient, condition for this transfer.

For example, the trade literature has discussed newer manufacturing techniques and processes such as numerically controlled machine tools, plasma deposit of materials, or explosive forming of materials. Undoubtedly, most potential commercial users are generally aware that these techniques exist. However, to accomplish a technology transfer, they need people who understand the techniques well. Our experience has been that for roughly 75 percent of the cases in which a new manufacturing process was successfully transferred within the Defense community, direct interaction of people was essential. The other 25 percent was accomplished through technical reports or symposia. I would expect that no less interaction is required for transfers to the commercial sector.

Transferring techniques, processes and concepts is also particularly difficult for a company without research and development capability. These companies probably find it difficult even to identify a particular technology which could improve their product. Then, if they recognize a potentially useful technology, the technical expertise required to fully appreciate the implications for their product line may be missing.

Thus, these companies require the assistance of persons—who might be called "translators" or "couplers"—who can help to identify and extract the technology, and then apply it to the company's product line through development, modification, or training.

We have looked briefly at the dynamics of the transfer process: the technology itself, the kinds of recipients, and the factors influencing possible transfers. I will turn now to a review of the DOD activities related to technology transfer.

DOD POLICY AND PROCEDURES ASSISTING TECHNOLOGY TRANSFER

First, the Department of Defense has active policies and procedures directly affecting the transfer of Defense technology to the private sector.

We publicize areas of procurement interest through the Department of Commerce Business Daily and other DOD mechanisms and meetings at which DOD R. & D. interests are exposed. This publicizing of prime and subcontracting opportunities is a catalyst for the ultimate transfer of technology to potential and interested contractors.

The award of R. & D. contracts is publicized, along with accompanying data defining the scope of the contractual work statement. This leads contractors to our Defense Documentation Center for data and reports; to interface with our engineering and research centers; and to discussions with project engineers.

We permit the sharing of services and facilities available in the Defense R. & D. community—such as wind tunnels and accelerators—which permits some transfer of technology.

Next, the Department's patent policy is designed to assist the prompt passage of scientific and technological developments into the civilian economy.

Essentially, the Department employs three approaches by the use of different contract clauses to serve the goal of achieving early civilian use of inventions. The first situation is where the goal will best be served by the Government acquiring title coupled with a liberal licensing policy—such as where the principal purpose of the contract is the exploration into fields which directly concern public health and welfare. In the second situation, where the contractor has demonstrated a technical competence in the area and ability to commercialize his inventions, the approach calls for the contractor to obtain title to the resulting patent, subject to a license in the Government. In such a situation, the normal incentives provided by the patent system are sufficient guarantee that the inventions will be exploited and developed for civilian use.

In the third and final situation the decision of patent rights is deferred until the invention is disclosed. This may be necessary where the commercial interests of the contractor are not sufficiently established to give title to the contractor at the time of contracting.

The Department of Defense also has a strong technical information program aimed at (1) efficiently transferring technical information within the Government and among contractors, and (2) making the maximum amount of technical information available to the general public.

During fiscal year 1967, about 330,000 copies of Defense technical reports were distributed to the general public through the Department of Commerce's Clearinghouse for Federal Scientific and Technical Information. In addition, over 1 million copies of Defense technical reports were distributed to Defense contractors by the Defense Documentation Center. DOD reports are published through two mechanisms: the DOD Technical Abstract Bulletin (TAB) published twice a month by the Defense Documentation Center, and the Commerce Department's U.S. Government Research and Development Report, also published twice a month. The Department of Defense generates over 50,000 new technical reports per year.

Though the Defense Documentation Center and other Defense technical information services were established primarily for Government contractors, the technical information has ready routes to the civilian sector. About 2,700 private organizations are registered for Defense Documentation Center services. Most of these companies serve the commercial as well as the Federal market.

Another element of the transfer of Defense technology is the mobility of scientists and engineers. There are over 300,000 U.S. engineers and scientists involved in the research, development, production, and operation of Defense systems. These technical people are a major, highly effective mechanism for technology transfer. We estimate that each year about 36,000 of these defense-connected employees change jobs, and that approximately 10,000 of them move to non-defense industry.

Technology transfer, often begins, in a sense, with the need to know who is working, or has worked, in a particular technological area. It is obviously essential to establish direct contact between the individual desiring information and the individual having the information. Technical reports are useful in identifying what has been done and who did it. However, they do not cover ongoing work. To provide the latter information, as well as management data, the Department of Defense instituted a uniform reporting system covering each separately distinguishable "technology effort"—DD Form 1498.

Each technology effort, called a work unit, is roughly equivalent to 1 man-year of effort. We currently have over 30,000 work unit records covering DOD and NASA technology efforts in our file. Each work unit record describes the objective of the work and identifies the principal investigator by name and address, in addition to other management information.

In addition to DOD and NASA employing a common work unit reporting system, essentially the same system is being extended to all Federal agencies. All of our unclassified reports are provided to the Smithsonian Institution's Scientific Information Exchange. In fiscal year 1967 the Defense Documentation Center processed over 3,000 individual requests from the work unit data bank. In addition to the distribution of technical reports and work unit information, the Defense Documentation Center provides over 20,000 bibliographies per year. The total cost of the varied DDC operations is approximately $10 million per year.

Supplementing the DDC, we have established either discipline or subject-oriented "information analysis centers." Typical examples, by technical area, are shock and vibration, human engineering, and ceramic materials. These centers, altogether funded at an annual rate of about $6 million, continually digest the pertinent developments related to their assigned subject or discipline areas.

Users requesting information from the center are given a customized individual response in terms most meaningful to them. Thus, the information analysis centers deal in information instead of merely documents. Often the centers publish periodic or special reports summarizing certain latest developments.

The effectiveness of our information analysis centers as transfer mechanisms is clear, though it is difficult to measure the benefits in concrete terms. For example, the Defense Metals Information Center handled an average of 127 requests per month for technical information. A large percentage—approximately 35 percent—of these requests represents repeat customers. That center also provides the results of their analyses in known areas of general interest to about 3,000 industrial organizations that have requested this type of information.

Let me add here some additional statistics relevant to Senator Nelson's questions this morning. We did a sample recently for fiscal year 1967 of user statistics for our information analysis centers, looking principally at the question: How many requests are we getting from small businesses? Taking five centers, and three categories of information, the ratio of small business requests to the total number of

requests ranged from about 13 percent to just short of 30 percent. That is to say, 13 to 30 percent of the requests of a selected sample of five information analysis centers, came from small businesses. Here we are using the criterion of 500 employees or less as a small business.

The Department of Defense also promotes the transfer of technology by encouraging employees to report their scientific and technical findings in appropriate professional journals and meetings.

Finally, an often overlooked mechanism for technology transfer is the professional consultant. We make extensive use of these highly qualified people. DOD consultants are in a position to transfer Defense technology both to and through their regular employer, as well as to private companies for which they consult.

CONCLUSION

I have tried to point out our ongoing activities and policies which contribute to the transfer of Defense technology to the private sector.

We are now in the process of exploring seriously a new practice that could significantly help industry. We plan to allow the public to utilize our information analysis centers in conjunction with an appropriate fee structure.

Senator NELSON. What do you mean by public, as contrasted with the groups now using it?

Mr. NICHOLS. There are now no restrictions on the kinds of requestors to our information analysis centers. However, they were mainly set up to serve the Defense community. What we in fact now do is delegate to the Director——

Senator NELSON. You mean they were set up to provide information to people who are in Defense contracting?

Mr. NICHOLS. Yes—in one way or another, in the Defense R. & D. community.

Senator NELSON. You are now saying you are contemplating making the information—the facilities—available to nondefense contractors?

Mr. NICHOLS. That is right. They are now available on a selected basis. What we do is delegate to the director of each center the responsibility for deciding how much of a response he can afford to make to a nondefense requester. What we are suggesting is that we will publicize the availability of these services, and we will establish some sort of fee structure for services, probably rather similar to the NASA program of fees.

Senator NELSON. How many centers do you have?

Mr. NICHOLS. Twenty centers.

Senator NELSON. And do you get information from NASA or the Atomic Energy Commission?

Mr. NICHOLS. We do, sir. These centers collect information relative to their subject areas from any and all sources.

Senator NELSON. Where are your centers located? I do not mean for you to name them all. Are they on university campuses?

Mr. NICHOLS. They vary. I think most of them are in fact on university campuses. In that sense it is similar to the NASA program. They are all over the country: University of Michigan, Johns Hopkins, Battelle Memorial Institute, General Electric-Tempo in California, American University in Washington, D.C.

I would be glad to submit a complete list of centers, locations, and functions, for the record.

Senator NELSON. I think it might be useful to have it in the record.

(The information referred to, subsequently received, follows:)

DoD SUPPORTED INFORMATION ANALYSIS CENTERS

Name: Ballistic Missile Radiation Analysis Center (BAMIRAC).
Address: University of Michigan, Institute of Science and Technology, Post Office Box 618, Ann Arbor, Michigan 48107.
Mission: Collect, process and disseminate information on the theory and technology associated with ballistic missile phenomena which may be useful in the design of defense systems. Analyze and evaluate theoretical and experimental results from the radiation measurements programs, with primary emphasis on the optical radiation emanating during the launch, mid-course and re-entry regimes of missile flight. Conduct semiannual AMRAC symposium and publish and distribute proceedings.
Subject Coverage: Ballistic missile phenomena: primary emphasis on optical radiation.
Name: Battelle-Defender Information Analysis Center (BDIAC).
Address: Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio 43201.
Mission: Collect, process and analyze information in all disciplines covering research in defense against ballistic missiles. Provide a functional information system required to monitor existing and proposed work. Perform analyses and undertake studies of critical system problems. Prepare state-of-the-art reports, technical summaries, compendiums and annotated accessions lists. Provide information services to the entire DoD ballistic missile defense community.
Subject coverage: Ballistic missile defense.
Name: Chemical Propulsion Information Agency (CPIA).
Address: Applied Physics Laboratory, The Johns Hopkins University, 8621 Georgia Avenue, Silver Spring, Maryland 20910.
Mission: Acquire the information and data from government sponsored programs in chemical propulsion technology; organize this information and data in the publications useful to members of the rocket community including government organizations, industrial concerns, universities, institutes and consultants working with chemical rocketry; disseminate chemical propulsion information and data through meetings, briefings, consultation and publications; serve as a central source for chemical propulsion contract information so that duplication in government funded research and development programs may be minimized; provide the Interagency Chemical Rocket Propulsion Group with status reports in specific areas of research and development to aid managerial decisions; provide technical data in response to inquiries from scientists and engineers engaged in chemical propulsion research and development.
Subject coverage: Research, development, test and evaluation information and data on chemical rockets. (This includes performance calculations of selected existing or theoretical chemicals, species and combinations; chemical synthesis; combustion studies; formulation of chemicals into solid or liquid propellant systems; physical characterization of chemicals and propellants; design of liquid rocket engines and solid rocket motors; ground tests of chemical rockets; integration of chemical rockets into flight vehicles and missiles; correlation of flight data and ground test data.)
Name: Cultural Information Analysis Center (CINFAC)
Address: c/o American University, Center for Research in Social Systems, 5010 Wisconsin Avenue, N.W., Washington, D.C. 20016.
Mission: This information analysis center has been established to provide a rapid-response capability system which can effectively store and retrieve raw data as well as completed studies in counterinsurgency, emphasizing the social, psychological, and economic sciences. It responds to requirements from appropriate U.S. governmental and civilian agencies by providing analytical information and data, in-depth studies, bibliographic information, consultant services and state-of-the-art reviews. Input is collected from the informational base provided by the extensive cross-cultural research program in behavioral sciences conducted by the Special Operations Research Office, as supplemented by

information received from the academic community, from special consultants, and from other governmental and civilian files.

Subject coverage: Remote area conflict and counterinsurgency, emphasizing the social, psychological, and economic studies.

Name: DASA Information and Analysis Center.

Address: GE-TEMPO, 816 State Street, Santa Barbara, California 93102.

Mission: The Center was established in 1961 by DASA to serve as a central collection point and reference center for all technical information pertinent to the effects of nuclear explosions. Its services are available to all responsible agencies and individuals conducting scientific investigations into the nature of nuclear weapon effects and their implications on present and future military systems. The Center enables rapid access to data from a wide variety of sources; announces, through its own publications, projected data collection programs, theoretical investigations, and experiments; frees other agencies from the responsibility for servicing requests for data; and forms a permanent archive of these data.

Subject coverage: Effect of nuclear explosions on electromagnetic propagation; effect of electromagnetic pulse on electrical and electronic material; air blast field predictions; blast scaling; blast loading and response, blast simulation techniques; hardened instrumentation; ionospheric instrumentation; computer programs used in NWER studies.

Name: Defense Ceramic Information Center

Address: Columbus Labs, Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio 43201.

Mission: Collects, processes, analyzes and disseminates scientific and technical information on ceramics and graphites. Provides a unified source of collated scientific information related to the science and technology of inorganic nonmetallic refractory materials for structural, nonstructural, electronic, and other applications for defense and civilian purposes. Collects, analyzes, evaluates, combines, and disseminates technical information on graphites, ceramics, and related materials. Defines deficiencies in available information and recommends greater or lesser effort in pertinent technical programs as appropriate. Products consist of reports, summarizing analyzed and evaluated data, consulting sevices. Input to the group is from DDC, the scientific literature, foreign technology, and direct contact with the scientific and industrial community.

Subject coverage: Ceramics and graphite science and engineering (Application).

Name: Defense Metals Information Center (DMIC).

Address: Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio 43201.

Mission: Collects, processes, and disseminates scientific and technical information on structural metals and closely related Aerospace materials. Provides answers to technical questions; information concerning current research and development projects; and scientific or technical data or data compilations upon request. No organized loan service. Makes technical evaluation of the accuracy, quality and significance of information that has already been introducted into the system. Prepares state-of-the-art reviews, correlations of information, etc. Technical consultant services.

Subject coverage: Properties, fabrication, and applications of aluminum, titanium, beryllium, magnesium, tungsten, molybdenum, columbium, tantalum, rhenium, stainless steels, hot-work die steels, low-alloy hardenable steels, nickel-base superalloys, cobalt-base superalloys, and iron-base superalloys.

Name: Electronic Properties Information Center (EPIC).

Address: Hughes Aircraft Company, Centinela Avenue and Teale Street, Culver City, California 90230.

Mission: This program is designed to provide ready access to literature and experimental data relating to the electrical and electronic properties of all materials of importance in today's technology. The literature is abstracted and indexed into an automated search system. Data from the literature are evaluated and compiled into series of data sheets. Summary and state-of-the-art reports are also issued. The abstracts, which are included with requests for bibliographies, identify the materials and indicate the experimental data contained in the literature. Requests for specific or related data are likewise honored.

Subject coverage: Semiconductors, insulators, electroluminescent materials, thermionic emitters, ferroelectrics, ferrites, ferromagnetics, superconductors, metals, ceramics, electronic materials and documentation of electronic properties.

Name: Hibernation Information Exchange (HIE).
Address: c/o Office of Naval Research Branch Office, 219 South Dearborn Street, Chicago, Illinois 60604.
Mission: To further the study of natural hibernation, particularly as it is known to occure in mammals. To provide rapid worldwide exchange of information between experts in hibernation.
Subject coverage: Mammalian hibernation and all related torpidities and dormancies in living creatures; such as occur in sleep and hypothermia.
Name: Human Engineering Information and Analysis Service (HEIAS).
Address: Tufts University, Systems Building, Medford, Massachusetts 02155.
Mission: Document acquisition; abstracting and coding of documents; preparation of indexing or categorizing schemes; and dissemination of human factors information in the form of user products such as an annual annotated bibliography of the literature, special bibliographies covering specific topic areas, and critical reviews of topic areas.
Subject coverage: Human engineering and analysis.
Name: Infrared Information and Analysis Center (IRIA).
Address: University of Michigan, Institute of Science and Technology, Post Office Box 618, Ann Arbor, Michigan 48107.
Mission: A Center for the collection, analysis, and dissemination of information on infrared research and technology. The services include the publication of annotated bibliographies, state-of-the-art reports, the *Proceedings of the Infrared Information Symposia*, a classified handbook on military infrared technology, the sponsorship of symposia, and the provision of library and consultation services.
Subject coverage: infrared physics and technology (including such areas as solid state physics, radiation physics and optics, infrared spectroscopy, atmospheric phenomena, information processing, military infrared equipment, and industrial and medical infrared).
Name: Mechanical Properties Data Center.
Address: Belfour-Stulen, Inc., 13919 West Bay Shore Drive, Traverse City, Michigan 49684.
Mission: Prepares and distributes evaluated strength data of aerospace materials. Primarily concerned with design, development, and operation of mechanized systems for storage, retrieval, evaluation and presentation of complex technical information. These information system developments are intended for immediate application, utilizing available hardware. Emphasis is placed on current practicality rather than sophistication. A further and basic consent applied to the storage and retrieval of technical information is that the actual technical information and data content of documents is stored, processed, retrieved and presented. Sources of information (bibliographies, lists of references, etc.) are also derived and presented, along with tabular and graphical displays of materials properties.
Subject coverage: Mechanical properties of structural materials with primary emphasis on metals, plastics, secondary, including test procedures, material formulation, processing, environments. Statistical evaluation of data.
Name: Military Entomology Information Service.
Address: Walter Reed Army Medical Center, Forest Glen Section, Washington, D.C. 20012.
Mission. To organize information relating to military entomology and associated fields, and to provide for its storage and retrieval. To prepare and maintain entomologic information by geographic areas of active or probable military interest for distribution as required to military organizations; respond to requests from individuals or organizations for specific information on military entomology; automatically distribute periodically annotated bibliographic citations of selected accessions to individuals whose fields of interest are made known to the AFPCB; and furnish duplicate copies of reprints on entomologic (or allied) subjects not available from Defense Documentation Center or local library facilities to military units.
Subject coverage: Military medical entomology and engineer entomology.
Name: National Oceanographic Data Center (NODC).
Address: Navy Yard Annex, Bldg. 160, Washington, D.C. 20390.
Mission: The NODC is primarily a central repository for the Nation's oceanographic data. Part of its mission is: to retrieve, compile, process, and preserve oceanographic data for rapid retrieval; establish procedures for insuring

that the accuracy and general quality of the incorporated data meet the criteria established by the Advisory Board, and prepare data summaries, tabulations, and atlases showing annual, seasonal, and monthly oceanographic conditions.
Subject coverage: All areas of oceanography; physical, geological and biological and related environments.
Name: Nondestructive Testing Information Analysis Center (NTIAC).
Address: U.S. Army Materials Research Agency, Watertown, Massachusetts 02172.
Mission: Collection, maintenance and dissemination of information in the field of nondestructive testing. Collects information from technical reports, the open literature and other sources. Stores the information in a rapid retrieval system, and disseminates this information upon request to government installations and others. Represents a service for those interested in information on nondestructive testing. Publishes NDT newsletters and report guides to literature in various sub-fields of nondestructive testing. Renders technical advice and assistance upon request.
Subject coverage: Nondestructive testing (Radiography, ultrasonics, electromagnetics, and various other NDT methods).
Name: Plastics Technical Evaluation Center (PLASTEC).
Address: Picatinny Arsenal, Bldg. 3401, Dover, New Jersey 07801.
Mission: Collect, exchange, collate, develop, and evaluate technical data on plastic materials of interest to the Department of Defense. Distribute these data and evaluations of them to DoD activities, their designees, or other organizations with demonstrable defense supporting interests upon request. Render technical advice and assistance on plastics to DoD activities upon request.
Subject coverage: Plastic materials of interest to DoD. Emphasis on plastics in structural applications (particularly weapons systems), electrical and electronic applications, packaging and mechanical goods applications.
Name: Remote Area Conflict Information Center (RACIC).
Address: Battelle Memorial Institute, 505 King Avenue, Columbus, Ohio 43201.
Mission: Collect, store and disseminate information concerning remote area conflict, emphasizing the physical and engineering sciences aspects. Provide a quick-response functional information system required to monitor research in counterinsurgency. Perform analyses and issue state-of-the-art reports and technical summaries. Provide information center services to all participants in remote area conflict and Project AGILE.
Subject coverage: Remote area conflict and counterinsurgency, emphasizing the physical and engineering sciencies.
Name: Shock and Vibration Information Center.
Address: Naval Research Laboratory (Code 6020) Washington, D.C. 20390.
Mission: To serve the Department of Defense, the National Aeronautics and Space Administration, and their contractors by the collection, correlation, and dissemination of needed information on the environmental factors shock and vibration.
Subject coverage: Mechanics, mechanical engineering, shock and vibration.
Name: Thermophysical Properties Research Center (TPRC).
Address: Purdue University, Research Park, 2595 Yeagor Road, West Lafayette, Indiana 47906.
Mission: To provide scientific and technical information based on a critical evaluation of previous data and if necessary new measurements and/or calculations in the thermophysical properties field. To provide authoritative and comprehensive source information on the thermophysical properties of *all matter* covering the world literature. To conduct experimental research on new determinations to fill in gaps and to reconcile discordant data of thermophysical properties.
Subject coverage: Thermophysical properties of all substances (all three phases), seven properties: viscosity, thermal conductivity, thermal diffusivity, diffusion coefficient, specific heat, thermal radiative properties, spectral and total (emissivity, reflectivity, absorptivity, transmissivity), coefficient of expansion, Prandt number.
Name: VELA Seismic Information and Analysis Center (VESIAC).
Address: University of Michigan, Box 618, Ann Arbor, Michigan 48107.
Mission: Collect, process and disseminate seismic and related information for the VELA UNIFORM program. Analyze this information and issue technical

summaries and state-of-the-art reports. Prepare a compendium, bibliographies, information digest and monographs. Provide information center services to VELA UNIFORM community working in the detection of underground explosions.

Subject coverage: Military seismics; seismology, subsurface explosions (including nuclear); ground noise; microseisms; artificial earthquakes; elastic waves; geological structure; ground movement instrumentation and detection; ocean bottom seismics.

Mr. CHRISTENSEN. Senator, I would like to make one comment in that regard. Not all of the centers would be applicable to the private sector. Some of them are in very specialized defense areas, such as ballistic missile radiation, which would not be of direct interest to the private sector.

I estimate that roughly 11 of the 20 centers have information which would be of interest to the private sector.

Senator NELSON. Does all of the information that your 11 centers have which is of interest to private industry—is it all furnished to NASA so they can feed it into their line dissemination centers?

Mr. CHRISTENSEN. The services of these centers are generally available to Government agencies and Government contractors, including NASA contractors, AEC contractors, and so forth.

Senator NELSON. That was not my question. My question was, is the information that the Defense Department has, that it considers valuable or usable by private industry, furnished automatically to NASA so that NASA can feed that into its nine dissemination centers?

Mr. NICHOLS. I don't believe there is a formal link between our information analysis centers and NASA's regional dissemination centers. These are separate activities. There is a great deal of casual exchange and reciprocal referrals. But to my knowledge there is no formal administrative linkage.

Is that your question?

In general both the NASA and DOD centers go to the same sources obviously—the same primary sources—for technical information. So in a sense the answer to your question is they tend to have all the same information. But I do not believe there is any formal administrative connection.

Senator NELSON. What do you mean they tend to be going to the same sources?

Mr. NICHOLS. Well, if you regard these information analysis centers or dissemination centers as intermediaries between a primary source of technological development and a recipient in industry, or someone who needs technology, the intermediaries clearly have to depend, generally speaking, on the same primary sources of technological development. Neither our information centers nor NASA centers are R. & D. labs per se. They are dependent upon the inputs they get from the originators of the information.

Senator NELSON. What I am interested in is all the information of any value to private industry, the private sector, that the Defense Department has furnished to NASA, so NASA can feed it into the dissemination centers?

Mr. CHRISTENSEN. All the reports that are originated by the information analysis centers are available to NASA and to other Government agencies. I do not know what disposition they make of these reports.

Senator NELSON. You say all of the reports that are made by your information centers are available. You mean if they ask for them?

Mr. CHRISTENSEN. Yes, sir.

Senator NELSON. Do you know whether they use them?

Mr. CHRISTENSEN. No, sir; I could not speak to that.

Senator NELSON. You say you have 11 centers—you have information that you consider valuable to industry. Is it classified in that way, or just sort of mixed up?

Mr. NICHOLS. This initial judgment is by broad subject area. This is a technical judgment we are making just by knowing roughly what is in these data banks. This is our judgment of how many would be largely relevant to industrial needs. I think the example Mr. Christensen gave—of ballistic missile radiation—would not be of interest to many small businesses.

Senator NELSON. If someone goes to one of the 11 centers where you have information which is valuable to the private sector, is it set up in such a way that you know this block of information here is all valuable, or may be valuable in one way or another to the private sector, or do you have to go through all your information to figure that out?

Mr. NICHOLS. Since we have not yet opened these centers up, we have not yet worked out all the details of identifying which subjects of information would be most useful. We would be glad to try to give you the status of our plans at the moment if you like. At the time they were opened, we would clearly want to have identified those subjects of information and services at each center that would be most useful to the public, and we intend to have done that by that point.

Senator NELSON. So that one who is seeking information can come to the center, or make an inquiry one way or another, and you will have isolated somehow this information that is useful to the private sector, as contrasted with ballistic information that is of no value to the private sector. Is that correct?

Mr. CHRISTENSEN. Senator, each one of our information analysis centers deals in a very specific subject or discipline area. One of our information analysis centers, for instance, deals strictly with ballistic missile radiation analysis.

Senator NELSON. All right. But you do not have any center that deals strictly with material or information that is of value only in the private sector?

Mr. CHRISTENSEN. No, sir.

Senator NELSON. It may be valuable or it may not. All I am getting at is—will anybody be able to say—we have x amount of information here, and 10 percent of it is valuable in the private sector, and that 10 percent is right here, I can pull it right out of the drawer and lay it in front of you. Or is it spread all the way through this complicated military information mechanism, and you would have to seek it out?

Mr. CHRISTENSEN. The function of the information analysis centers is to seek out all of the information, whether it be in the military sector or the NASA sector, or the private sector, which is applicable to their particular area of interest. They then, when they receive an inquiry from a concern for answers to a specific question, draw upon this information bank which they have established and provide them with the best answer that they can.

Senator NELSON. It is still not clear to me.

Mr. NICHOLS. Let me add one other comment, Senator Nelson, that may be helpful in clarifying this point. It seems to me the question you are raising now is related to another point you raised earlier this morning, and that is, people that have the information may not know a great deal about the problems of the requester of the information. So I think we would probably not want to define rigidly categories of information that we felt in advance would be applicable. We would try to be as sensitive as possible to the particular problems that the requester had. I believe one could probably go too far in terms of rigidly defining information on a guess as to what might be applicable. We would like to try to avoid that and exploit as much as we could the total information we have available.

Senator NELSON. Will all this information, then, be furnished to NASA and put into their centers, so that the businessman is not going to have to go to three or four places?

Mr. NICHOLS. We have already begun discussions with NASA, trying to learn from their experience and share our experience with them. We will consult with them prior to the time of opening up these centers, should we decide to do that. We would probably like to develop a more formal link between their program and ours than now exists.

The focused technical services of these centers could improve the coupling of potential private users to Government technology. They would, in part, serve the "translator-coupler" role that I previously discussed.

Aside from encouraging the transfer of technology, the success of these centers—as measured by the private sectors' willingness to pay for the services—will furnish insight on the advisability of additional Department of Defense technology transfer actions. We will work closely with all Federal agencies to assure that our experience with the information analysis centers is considered along with other experiments in technology transfer.

Senator NELSON. I have a 12 o'clock engagement. We will have to conclude. There will be some questions we have not asked yet, but which we will submit.

Mr. NICHOLS. We will be happy to respond.

Senator NELSON. Thank you very much.

(The supplemental information submitted by Mr. Nichols follows:)

OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING,
Washington, D.C., October 16, 1967.

Hon. JENNINGS RANDOLPH,
U.S. Senate,
Washington, D.C.

Dear SENATOR RANDOLPH: I am pleased to provide the enclosed responses on behalf of the Department of Defense to the questions posed in your letter of October 2, 1967.

I would like to stress that the Department of Defense is most concerned with the many facets of technology transfer brought to light by the activities of your Subcommittee. We will continue to study and, where practical, institute technology transfer mechanisms consistent with the Defense mission.

Sincerely yours,

RODNEY W. NICHOLS,
Special Assistant to the Deputy Director
(Research and Technology).

Enclosure.

RESPONSES TO QUESTIONS POSED BY SENATOR RANDOLPH

Question No. 1: "How many technical documents result each year from DoD funding of scientific R&D? How many are security classified? How many are otherwise restricted and on what grounds? How many are released to the Commerce Clearinghouse for general dissemination? How many are provided to the NASA dissemination system?

The Department of Defense's Defense Documentation Center accessions about 50,000 new technical reports annually. In FY 1967 the actual number accessioned was 49,640. Of this total 8,925 were classified in accordance with Executive Order 10501. 19,217 of the reports were provided to the Department of Commerce's Clearinghouse for Federal Scientific and Technical Information and offered for sale to the general public. Of the remaining 21,498 reports, 9,750 are releasable to individual U.S. citizens or organizations but cannot be exported since the information contained therein is restricted by either the Department of State's International Traffic in Arms Regulation (ITAR) or the Department of Commerce's Commodity Control List. 8,448 unclassified reports were restricted to U.S. Government use, because they contain information relating to the test or evaluation of commercial products or contained proprietary rights not owned by the government. 2,640 unclassified reports were restricted to DoD use, on the basis that they contained information on negotiations between U.S. government agencies, evaluation of other agencies' or their contractors' programs, trade secrets, and related causes requiring disclosure only within the Department of Defense. The remaining 660 unclassified technical reports were restricted to specified individuals because they contain information such as personnel data, evaluation of DoD components, and invention disclosures by DoD personnel.

It should be noted that all unclassified DoD technical reports which are restricted for one of the reasons indicated may be released outside of the area specified in the designated restriction with the permission of the controlling DoD office. In FY 1967, over 30,000 such approvals were obtained on a case-by-case basis.

In FY 1967 NASA selected approximately 18,000 DoD technical reports for inclusion in their dissemination system. About 1,800 of these reports were classified; 7,600 were unclassified but their distribution was limited for one of the reasons previously mentioned; and 8,600 were unclassified and unlimited.

Question No. 2: "Please briefly discuss the dissemination restrictions which result from allowing contractors to commingle proprietary information with Government-owned information in technical documents. What percentage of documents are excluded from wide public distribution because of this restriction?"

In general, Government-owned information is not restricted by virtue of it being commingled with proprietary information of a contractor, since the exercise of the contractor's rights in no way affects the unlimited rights the Government may have in technical data. The Government's acceptance of technical data subject to limited rights does not impair any rights in such data to which the Government is otherwise entitled or impair the Government's right to use similar or identical data acquired from other sources. Where a particular report contains both Government and contractor information developed at private expense, it may receive a restrictive legend since a commercial organization has a valid economic interest in data developed at its own expense. Department of Defense acquisition of limited or unlimited rights is generally determined under ASPR Section IX, Part 2, by inserting appropriate requirements in the contract. The Department of Defense, however, does not have any practical method of precisely identifying the number of technical reports whose distribution is limited because they contain contractor's proprietary information commingled with Government-owned information.

The Department's policy with respect to acquiring data and the rights therein is an attempt at balancing the interest of the Government in obtaining technical data essential to its needs and the responsibility associated with fostering technological progress from its research and development, while at the same time insuring Government respect for its contractor's economic interest in technical data relating to privately developed items. Such a balance is important in maintaining successful contractual relationships and providing an incentive to develop at private expense items of military utility.

Question No. 3: "Please briefly discuss the technical data export control regulations. How do these laws affect accessibility to DoD information by U.S.

companies? What proportion of DoD information is restricted on this basis from being furnished to the Clearinghouse?"

The export of technical data is controlled by the Mutual Security Act, Title 22 U.S. Code Section 1934; the Export Control Act, Title 50 U.S. Code Appendix Section 2021 et. seq.; and the Mutual Defense Assistance Control Act, Title 22 U.S. Code Section 1161. The Mutual Security Act and the Export Control Act are administered by the Department of State and the Department of Commerce respectively. Their regulations are contained in Title 22 Code of Federal Regulations Chapter 1, Part 125 and Title 15, Chapter III, Part 385. Generally, these regulations provide that a license must be issued by either the Department of State or the Department of Commerce for the exportation of technical data relating to the Munitions List or the Commodity Control List.

These laws do not theoretically restrict dissemination of affected technical reports to any U.S. company. However, from a practical point of view, non-government contractors have difficulty in recognizing the availability of specific reports since they are not announced publicly. The Department of Defense has an arrangement with the Clearinghouse whereby they will sell any DoD report in this category to any U.S. citizen or organization when specifically requested.

If the unclassified reports in this category could have been publicly announced and sold, the FY 1967 DoD contribution to the Clearinghouse would have increased by 43 percent.

Question No. 4: "Please briefly discuss the recently implemented public information section of the Administrative Procedures Act passed by the last Congress. Are the results of Federally sponsored R & D excluded from this Act which was designed to give greater access to Executive Branch information? What proportion of DoD technical data is excluded from Clearinghouse dissemination on this basis?"

The Public Information Section of the Administrative Procedures Act, Title 5, United States Code, Section 552, which became effective on July 4, 1967, provides that information will be made available to members of the public unless the information falls within specific categories which are exempt from public disclosure. The pertinent provision of that legislation with regard to this question is subsection (a)(3). This subsection provides that identifiable records must be made available to the public on request. However, the Department of Defense has not considered all technical reports to be within the intent of this legislation. In this connection the Department has followed the Attorney General's memorandum dated June 1967, in implementing the Public Information Section. In that memorandum the Attorney General stated: "An important consideration should be noted as to formulae, designs, drawings, research data, etc., which, although set forth on pieces of paper, are significant not as records but as items of valuable property. These may have been developed by or for the Government at great expense. There is no indication anywhere in the consideration of this legislation that the Congress intended, by subsection (c), to give away such property to every citizen or alien who is willing to pay the price of making a copy. Where similar property in private hands would be held in confidence, such property in the hands of the United States should be covered under exemption (e)(4)." (See page 34, Attorney General's memorandum)

Though the Department does not consider that this legislation is generally applicable to research and development technical reports, we have not excluded any technical information from the Clearinghouse on this basis.

Question No. 5: "What is the opinion of DoD with respect to including a new technology reporting clause in its R&D contracts? If the cost-benefit of such an action is in doubt, what could be done to clarify the situation? To what extent should the DoD provide the 'translators or couplers—who can help to identify and extract the technology' according to your statement?"

The Department of Defense does not believe that a technology reporting clause, over and beyond the present requirement for technical reports and data, is warranted at this time for use in DoD R&D contracts. As indicated in the question, the costs and benefits of such techniques are not yet known. The NASA experiments designed to obtain information on the costs and benefits associated with various technology utilization programs have been and will be, closely followed by the DoD. We do feel that identical experiments within the Department of Defense are warranted until the NASA experiments have been evaluated. The DoD does plan to obtain increased insight into the technology transfer process by allowing the public to utilize approporiate DoD Information Analysis Centers

on a fee basis. This experiment will provide some critical information on what potential users want and are willing to support.

In our judgment, the "coupling" or "translation" functions are provided fairly effectively by consultants, meetings, various publications and the other mechanisms enumerated in our testimony. These are, of course, generally informal and decentralized activities. Also, the Department of Defense participates with other agencies in programs having a direct impact on the private sector when such endeavors are clearly consistent with the defense mission. The recently announced agreement with the Department of Commerce on a master plan for future development of large, fast, surface-effect ships is an example of this type of cooperation.

DoD support of additional technology transfer functions, other than those required in support of the Defense mission, must be based on the cost of such functions compared to the benefits accrued to the national security. We recognize that national security can and should be understood broadly to include the strength and quality of our industrial base. This is the reason for our comprehensive technical information program and for our continuing interest in the technology transfer process. Thus, should the Subcommittee's investigation clearly indicate that additional Government-wide technology transfer effort is warranted, the Department of Defense will be pleased to consider appropriate programs. Clearly, such programs will be examined by us, and by Congressional appropriations committees, in comparsion with other Defense projects.

(Whereupon, at 12 noon the subcommittee was adjourned, to reconvene subject to the call of the Chair.)

TECHNOLOGY TRANSFER

THURSDAY, SEPTEMBER 28, 1967

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE AND TECHNOLOGY OF THE
SELECT COMMITTEE ON SMALL BUSINESS,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10 a.m., in room 1202, New Senate Office Building, Senator Jennings Randolph (chairman) presiding.

Present: Senators Randolph and Dominick.

Also present: Blake O'Connor, professional staff member; Daniel T. Coughlin, minority counsel; and Richard A. Carpenter, Legislative Reference Service, Library of Congress.

Senator RANDOLPH. We continue our hearings of the Subcommittee on Science and Technology of the Select Committee on Small Business of the Senate.

Robert Moot and his associates from the Small Business Administration will give us the advantage of their experience. I am sure the formal statement and the counsel they will present will be helpful.

Mr. Moot, will you give the names of your associates also, and their positions within the organization, or have the gentlemen do it as we begin the hearings?

STATEMENT OF HON. ROBERT C. MOOT, ADMINISTRATOR, SMALL BUSINESS ADMINISTRATION, WASHINGTON, D.C.; ACCOMPANIED BY HOWARD GREENBERG, DEPUTY ADMINISTRATOR; AND IRVING MANESS, ASSOCIATE ADMINISTRATOR FOR PROCUREMENT AND MANAGEMENT ASSISTANCE

Mr. MOOT. Thank you, sir.

On my right is the Deputy Administrator of the Small Business Administration, Mr. Howard Greenberg, and on my left is the Associate Administrator for Procurement and Management Assistance, Mr. Irving Maness.

With your permission I will go right ahead with my statement, Mr. Chairman.

I appreciate this opportunity to appear before you to discuss technology utilization and technology transfer as they relate to small business.

Aptly described as the "technology explosion," the steadily accelerating proliferation of technical advances and innovations today poses both a serious threat and an awesome challenge to the small business community, particularly the small manufacturers.

The small manufacturer's survival in our traditional competitive environment will become more and more difficult, unless that environment helps him share more immediately and abundantly the fruits of these advances.

Invention and innovation, like small business itself, lie at the heart of the process by which America has grown and renewed itself. There is a significant relationship between innovation and economic growth.

Although the economic progress of small business has been impressive, unfortunately all segments have not fared well. Today's position of the small manufacturing community was clearly presented by my predecessor, Bernard L. Boutin, before the Senate Select Committee on Small Business on March 1 of this year. This report in part stated:

> Analysis of the value added to our economy in the past 15 years by large manufacturing concerns shows that with possible exception of two industries—petroleum and coal products, and rubber and plastics—the large manufacturer gained at the expense of the small manufacturer.
>
> The rate at which sales increased for large manufacturers between 1951 and 1956 was nearly double that for small manufacturers.

These setbacks stem in part from the difficulty small manufacturers have in taking advantage of new tchnology. I am hopeful that this committee's inquiry into these problems, particularly those concerning the transfer of useful technology from federally sponsored research and development, will help bring a reversal of this trend.

I might add parenthetically, Mr. Chairman, that in the past 7 years this adverse trend has been somewhat slowed, particularly in the manufacturing field. While it is still very difficult for small businessmen to enter the field, those that are in the field, who are receiving Small Business Administration assistance, have been doing relatively well in comparison with the rest of the manufacturing industry, particularly in sales growth and in profit trend. We recently testified to this effect before a subcommittee of the Senate Select Committee on Small Business.

Senator RANDOLPH. Mr. Moot, I interrupt to say that just a few days ago I was in Summersville, W. Va., and at that time I had an opportunity to see the growth of Bright of America, the greeting card plant. They had three or four or five workers to begin with. The employment is now some 65, and it is anticipated it will go to even three or four times that figure.

Now, SBA has been active in helping in that development. But beyond SBA, there was a creative person at the head of that company. And I think this is very important.

You can work with that sort of person, can't you, much more easily than you can with a person who says "I just need some help." But if the man can come in and show "I need help because I am going to be able to do this," and can lay out a program, that appeals to you, isn't that true?

Mr. MOOT. That is absolutely right, sir. It is vital to have a creative drive in terms of the management team in a small business concern.

Actually, we think that that is one of the prime problems of the subject you are talking about today. There has to be a desire not only to make more money, but there has to be a desire to be able actively to use data and technology as it is provided. Of course, we consider

it our basic responsibility to provide the link between that man, who will make use of it, and one of the appropriate repositories, provided throughout the country, in order that it can be of use to him.

We are, frankly, Mr. Chairman, quite gratified with the growth rates of the small business concerns that we are helping. Our problem is the same problem you are looking at—how to get new small business concerns to enter the various segments of the manufacturing field.

Senator RANDOLPH. I remember at Fairmont, W. Va., for example, there was a plant that was given help at certain periods, and the help was not to keep a plant operating, to keep a business from going under—the help was to increase the employment at that particular plant. I am not going to give you its name, because I might be in error—but it shows a constant increase in employment, with the aid of SBA funds.

Mr. MOOT. Those concerns that have the initiative, have the creative ability, and have the management drive, are the type of concerns that are showing the growth rates that we are quite gratified with. They are better than large concerns, and better than industry as a whole. The trouble is, we just do not have enough of them.

To continue—the Small Business Act itself actually defines the problem, and points the way to the agency. Section 9(a) states in part:

> The expense of carrying on research and development programs is beyond the means of many small-business concerns, and such concerns are handicapped in obtaining the benefits of research and development programs conducted at Government expense. These small-business concerns are thereby placed at a competitive disadvantage. This weakens the competitive free enterprise system * * *.

It is, thus, the role of the Small Business Administration in technology transfer to identify technological needs of small manufacturers and research and development concerns, locate related sources of technology to satisfy those needs, and provide technical, management, and financial assistance effectively to utilize technology.

Until quite recently, SBA concentrated its efforts on assisting small concerns to obtain Government R. & D. contracts as required by section 9(b)(1). While desirable, we realize that this is a limited program especially since, despite all our efforts, the contract awards to small business in military R. & D. fell from 4.4 percent in fiscal year 1966 to 3.9 percent in fiscal year 1967. While increasing our efforts in the contract awards area, we have now broadened our effort to include section 9(b)(2) and (3), to assist small business concerns to obtain the benefits of R. & D. performed under Government contracts and to provide technical assistance to them.

Senator RANDOLPH. I think this technical assistance program has a promising concept, Mr. Moot. And yet it poses certain questions that I am sure you have as well as members of the subcommittee.

We are going to have to have manpower to do this job, are we not?

Mr. MOOT. Well, sir, a good part of the job will be done, we hope, for us by other agencies of the Government and by the states—as the State Technical Services Act becomes more fully implemented, as the Commerce Clearinghouse becomes more active, and as we make better arrangements with the Defense Department, and with the Defense Documentation Center. The biggest problem, as we see it, is a twofold problem, Mr. Chairman. First, to be able to get the technical data in

the repositories in that shape or condition where it can be used by a small manufacturer. And the second big problem is, through workshop seminars and conferences, to be able to explain to the manufacturer how to use the data. We consider this a responsibility of the Small Business Administration.

We do not consider that the Department of Commerce, either initially, during consideration of the State Technical Services Act, or currently, properly regards it as its responsibility to help the small businessman specifically.

I think that is our job. And this is the job that we are embarking upon now. And I hope that during this year we are showing considerably greater progress than we have in the past.

Senator RANDOLPH. I am not certain whether you are saying that this is a program that can be effective, and can be effective within the assistance which can be given from other agencies of Government working through and with the SBA. I had felt that we would need, frankly, a program of this kind, with counselors in the field, and a funding, frankly, of the effort.

Would you comment on that thought that I have expressed?

Mr. MOOT. I think you are absolutely right. Perhaps I confused the issue by stating it from my viewpoint rather than from the overall one.

There is no doubt in my mind that a greater effort must be expended in terms of preparation of the data for dissemination and application, and greater effort and funds must be expended in acquiring manpower which can actually do the explaining.

I was expressing the SBA's viewpoint, i.e., that this is not really an SBA responsibility at this stage—this is a Department of Commerce and the States' responsibility, as we understand the intent of Congress.

We would move in at that stage with our small business concerns, the very concerns that you mentioned before, the ones that are alert to opportunities and have a desire to grow, expand, and enter into new products, the ones that have an innovation in mind, and attempt to maximize their utilization of this data. That is the role I see for the Small Business Administration.

Senator RANDOLPH. I think that is a clarification that helps our record here, because we are not at the opposite viewpoints.

Mr. MOOT. No. I think we have a complementary role and a very important one.

Section 9 of the act suggests other permissible activities in R. & D., but within the realities of what can be most effectively accomplished in the near future, we believe SBA must first establish a viable technology utilization and transfer program.

EARLIER SBA EFFORTS

Two years ago, as we began to study the problem, we initiated consultations with both the National Aeronautics and Space Administration—NASA—and the Atomic Energy Commission—AEC. This resulted in separate interagency agreements between SBA and NASA and SBA and AEC on pilot projects that would enable small manufacturers to benefit from the spinoff from NASA and AEC research.

In the NASA project, that agency directed three of their four re-

gional dissemination centers—RDC's—to transfer meaningful technology to certain small manufacturers and R. & D. concerns selected by SBA. In all, 18 small companies participated in this project.

With the Atomic Energy Commission, the program set up conferences for small businessmen at Argonne National Laboratory, near Chicago, where scientists and engineers discussed, in general terms, the areas in which technology was available to the business community and demonstrated innovations by shop visits.

These pilot projects were completed late this past spring and, together with the findings of your subcommittee as reported in "Policy Planning for Technology Transfer," April 6, 1967, they provided us guidance and direction for certain programs which I have approved for the present fiscal year.

One-third of the companies in the NASA pilot project reported that technology transfers were sufficiently significant to warrant their continuation with the RDC's as regular fee-paying members. Of the remainder, half recognized the value of the RDC transfer method, but they either felt they could not afford the fee or could not utilize the advanced technology effectively at this time. The remainder were generally noncommittal.

With many small companies, operations are headed by a single individual who also has responsibility for the technical input. In most cases, the tendency is to neglect this latter function.

The AEC pilot produced six conferences attended by approximately 450 companies. In these conferences, the small manufacturers fell into the same three groupings. Here again, the small companies that seemed to get the most out of the briefings were the more technically sophisticated that had in-house technical resources.

The task we face is to stimulate and motivate the others. They must acquire and assimilate new technology, or fall behind. SBA is taking a course geared to educating the small business community through conferences, seminars, and workshops and giving technical assistance through counseling.

PRESENT SBA EFFORTS

Technology dissemination

Our program for technology dissemination and utilization has several prongs:

We are initiating a regular summary of selected inventions and innovations, generated by Government-sponsored research and development, which appear to have commercial and industrial potential, and channel these publications to specific industry groups or individual concerns.

We have deployed eight technology utilization officers at strategic locations across the country to help disseminate these publications as well as other new information, and to help small firms assimilate this new technology.

These technology utilization officers will also use our SCORE volunteers in this effort.

Senator RANDOLPH. At this point, Mr. Moot, I think what you are doing is very affirmative, and I commend the effort.

What I now say—I do not want this to be construed as attempting to downgrade that program.

But I am wondering whether we might run into a situation, let's say, that could be similar to that in England, where, if I am correctly informed—and I may be in error—let's use the word "bureaucrat," not in any offensive sense, but a person who is within the structure of government—who makes the choice, let's say, on his own, rather than the person in industry helping to make the choice of a project or projects.

There might be a possibility, I think, as there was in England, of certain pet projects just being pushed out of proportion to the projects, that, on a look from those within a group that could be selected to join with you, might be helpful.

Now, in other words, as we look into the innovations, into the inventions, can't industry, as well as Government, be a part of that selectivity and action that will flow from it?

Mr. MOOT. Mr. Chairman, I fully understand and appreciate your comment. I recognize the potential danger.

What Mr. Maness is doing in this particular area is to contact the industry associations, of which there are many in Washington, as you know, and we are picking the particular segments of the manufacturing field that appear promising in terms of new innovation, and particularly those that have a good opportunity for small business, and we are asking them to cooperate with us in reviewing technical briefs and the various inventions that we can, in turn, distribute through their industry publications as well as through our own seminars.

So I think we are, while recognizing the problem you are raising, taking the necessary steps to overcome any tendency to become ingrown in terms of the Government providing this information.

Senator RANDOLPH. I felt that that was being done. In fact, I had information to that effect—the program under Mr. Maness being not one of blocking these people in industry away from the effort, but the joining of those people in that group with you under a, let's say, two-pronged approach, and I commend you.

Mr. MOOT. Actually I think we gain many things in terms of the Federal Government. We gain the knowledge of the industry, No. 1. We gain the technical ability of the personnel of the industry associations. And we get good dissemination through industry publications throughout the country, all within the industry and all geared to the industry needs. So we are adding emphasis to this aspect of our program.

We are continuing the close relationship with NASA and AEC by cosponsoring conferences in which large audiences of small manufacturers and research and development—R. & D.—firms are exposed to technological advances that may have commercial potential for them.

Interest generated by these conferences among the participants will be pursued in more depth in seminars for single industry groups.

In addition, workshops for individual concerns with particular technical problems will follow. Engineers and scientists from Government agencies or educational institutions will come to instruct small businessmen in these workshops.

We recognize, of course, that, in addition to NASA and AEC, there are many other sources of technology in the Federal establishment. For example, the Department of Commerce Clearinghouse for Scientific and Technical Information is a repository for the total Federal research and development output, except that which is classified. Our experience shows that it is difficult for small business concerns to obtain and assimilate specific documentation or reports from the clearinghouse because these concerns lack technical depth. Not insignificant is the expense involved in obtaining reports leading to specific solutions.

Another source of technology which should be fruitful for the small business community is the Department of Defense. Its classified information is disseminated through the Defense Documentation Center to qualified and security-cleared concerns.

We are presently exploring measures to improve small business access to both of these stores of information.

The State Technical Services Act—STSA—which became law in October 1965, is meant to increase, at State levels, the transfer of technological information to civilian industries within the several States. As this committee's report notes, the services provided under the STSA are limited to early counseling and are intended not to interfere with private consulting and development firms. We are in continuous contact with the STS program at State levels and in a number of States are contributing SBA expertise through seminars and workshops. We are also collaborating with several States in the planning of technology transfer programs.

For example, in Illinois SBA has a representative on the steering committee and assists in planning and staging conferences, such as the one held in March 1967, at the University of Illinois, on computer technology for the building industry, attended by approximately 150 companies. In California an SBA representative sits on the State Technical Service Advisory Council's Program Evaluation Committee.

In the same vein, SBA also participates in study groups of the Committee on Scientific and Technical Information—COSATI—and is consulting with the Council of Defense and Space Industry Association—CODSIA.

Management assistance

It has long been recognized that technology utilization is a management problem and that transfers are most effectively made through the face-to-face contact which we call counseling. In addition to our own technically trained personnel engaged in counseling, we draw upon retired scientists and engineers, as well as trained executives, who are volunteers in the Service Corps of Retired Executives—SCORE. They work directly with small business concerns as counselors and assist in the solutions of both management and technical problems.

Financial assistance

1. *SBA loans*

The loan programs of SBA are also being brought to bear on the problems facing small firms in product development. A new approach is the "innovation loan." Recognizing that risks are high in the innova-

tive process, but that prospective returns to the economy may even be higher, SBA last April embarked on a policy to seek out and assist small manufacturing concerns with qualified management eager to introduce new products, processes, or techniques.

The criteria for these innovation loans go beyond the company's financial condition, credit standing, and collateral. We try to assess whether prospective economic return on the innovation will be beneficial to the national economy or welfare. We have made some 47 innovation loans since April which total more than $3 million. SBA's innovation loans will continue to be expanded to meet the special needs of small firms and the economy.

2. SBIC's—equity financing

As mentioned earlier, we are aware of the higher risks of developing new products and processes, as compared to the risks encountered by firms producing established products or services.

Senator RANDOLPH. I see you indicate the amount of these loans since April total some $3 million. I realize that this is a high-risk loan, is that true?

Mr. MOOT. They are generally higher risk loans than our average loans.

Senator RANDOLPH. So we are making that amount of money available that you have indicated, and it is in the mill.

What might we expect eventually to be used in this type of loan?

Mr. MOOT. In terms of dollar value, Mr. Chairman?

Senator RANDOLPH. Yes.

Mr. MOOT. I think that we would continue to search out for the next year the type of loans that we would consider making in this area, and then we, on the basis of actual experience, would set up a program.

It would appear as though we should start in the neighborhood of $10 million to $15 million, until we find that we have developed products or processes or techniques or methods which have been truly innovative, and have contributed to the economy. Then, because this is one of the mandates that Congress has given us, I think we should continue to expand this program. And we would be looking forward to interfacing this program more closely with the technology that is available in order to make innovation more feasible and possible and beneficial.

I really cannot give you a specific answer as to how much of a program we will end up with, but I would say we would continue to emphasize this program and put funds in it as warranted, sir.

Senator RANDOLPH. I approve the thinking that you have expressed, because I think this type of loan is a loan that can be repaid and will be repaid, because the fact of innovation and experimentation in a way indicates, not that you are just taking a chance, but that you are dealing with someone who really has an idea, who really has something that he thinks can be done. And you, of course, have checked into it to know that it did not come into being just by a dream. He had to have a dynamic effort flowing into it.

What has been the success or failure, if you have anything to base it on, of this type of loan, up to this date?

Mr. MOOT. It is a little early, sir. Mostly the funds we have provided so far in these 47 loans are in a setup or startup early stage situation.

Several of the concerns—actually some of them started in the basements of their homes—have sizable orders, and are working on them. We expect that they all will make it at this moment. There is nothing that looks pessimistic to us at this time. We are going to give them all the help we can in terms of management and technical assistance. We are going to be watching them very closely, because we believe it is in this area that the greatest promise appears in the whole spectrum of our program.

Senator RANDOLPH. This may not be the best way to express it, Mr. Moot, but when we spend a dollar, let's say, in this type of loan, I think we can expect or hope that it not only be repaid, but if it is repaid, had the loan been made and repaid and that is the end; no. You have a dividend which will accrue, maybe a month from then or a year from then. That dividend will be more jobs, a strengthened economy, showing to another company what a competitor perhaps has been able to do.

So you stimulate, you generate, you build an incentive into our general program of small business.

I am not, as you would not be, interested in frittering money away, but certainly in following through with the company that seems to have done enough digging, even though the innovation, the invention is new—that you want to join and help make that effort profitable.

So even though we call it high risk, I think it is merited. Of course, there are those who think—if we just give counseling to these firms, they can do it.

But you feel there have to be dollars involved also, is that true?

Mr. MOOT. I think this is amply true, and amply justified. The high risk is returned by high promise. I feel sure these will turn out to be very fine loans.

Senator RANDOLPH. Mr. Moot, to you and your associates, I will indicate that Senator Dominick is here with us at this time.

Senator Dominick, as others on this subcommittee, has attempted, insofar as possible, to participate in these hearings. He is going to assume the Chair at this time. Perhaps I will be able to come back to hear your testimony and that of your colleagues a little later this morning.

Senator Dominick.

Senator DOMINICK. Thank you, Senator.

Mr. MOOT. I am just starting at the top of page 11, Senator.

Senator DOMINICK. Go right ahead, Mr. Moot.

Mr. MOOT. As mentioned earlier, we are aware of the higher risks of developing new products and processes, as compared to the risks encountered by firms producing established products or services. For this reason and others, we foresee that the needs of many small innovative businesses may be better served by equity financing than by loans. SBA makes this type of assistance available to small firms through the small business investment company program. Quite recently, SBA has issued an SBIC license to the Financial-Technical Assistance Corp. in Waltham, Mass. This new firm will begin operations with $525,000 in privately subscribed capital, with plans to furnish equity financing and long-term loans to technically oriented small businesses.

CONCLUSION

We feel that during this year we must further develop and refine the program outlined in this statement. However, there is much more that can be done and I would point to several areas discussed in the committee report.

We should like to see much greater emphasis given to the development of technology utilization programs for small business in the country's research institutes and universities.

The small manufacturer is being squeezed by his financial inability to support the highly qualified staffs and/or specialized facilities required in research and development. It appears that only a program specifically geared to the needs of small business will provide small manufacturing firms with the kind of technological assistance they need to survive in our strongly competitive and highly innovative economy.

We also intend to urge Federal agencies engaged in research to adopt a policy which would require R. & D. contractors to expand their final mission reports to cover possible commercial uses for the development on which they are reporting. We have named this new research reporting method "Project Foresight," to distinguish it from "Project Hindsight" of the Department of Defense, which is surveying the technology developed through military weapons systems contracts over the past 20 years.

Unlike this latter retrospective approach, Project Foresight would require Government R. & D. contractors to report possible future commercial uses of their technical findings and, thus, share such findings with specific industry segments which might make practical application thereof.

Based on this approach, SBA's rule would be to induce qualified small manufacturing concerns to interest themselves in commercial applications of new technology, to educate them in such possibilities through conferences, seminars, and workshops, and to make funds available through loans or equity financing to help them participate in this technology utilization process.

We are considering other possibilities, such as pooling arrangements between companies willing to band together in technology transfer efforts.

Admittedly there are complex problems yet to be solved in the whole question of technology utilization. We know that there have been some impressive transfers. We also know that in many cases, transfers producing commercial uses are not readily visible. They travel a long, hard road. As Dr. Charles N. Kimball, president of Midwest Research Institute, has written in "Applied Science and Technology Progress," a report to the National Academy of Sciences:

> Technology transfer is perhaps most significant at the level at which cumulative small bits of new information are recombined and put to new uses. At the present time, it is difficult to manage this process and to measure its profitability. Explicit research into the transfer process is needed.

Mr. Chairman, I thank you and your committee members for your attention. I hope my statement has been helpful to you, and that within the near future we may meet again to discuss the results of our efforts

to provide small businesses with a fair share of the vast technological data now in Government storehouses and flowing from federally sponsored R. & D.

Senator DOMINICK. Mr. Moot, I very much appreciate your fine statement. I wish I had been here to listen to all of it. But I certainly will have the opportunity of reading it.

I do want to say that your regional office and the main office prior to this time have been of great assistance to me and my staff. I appreciate it. The cooperation has been very fine.

I would like to ask you about Project Foresight, which in my opinion is an interesting concept.

What response have you received from research and development people?

Mr. MOOT. We are really just starting. This idea of ours—actually it appeared in your committee print, when you looked at it, and published in April of 1967, Senator. Based on our discussions—Mr. Maness has made the initial contacts.

There are several difficult technical problems to be worked out in terms of how to do this, and also the question of whether the cost of the R. & D. effort will be significantly affected by the requirement to add this latter step, which is to convert it to potential commercial application.

Senator DOMINICK. Are these R. & D. contracts solely Government financed?

Mr. MOOT. Yes, sir.

Senator DOMINICK. Do you get into problems of patents and copyrights?

Mr. MOOT. Well, that same problem is likely to appear, because some of the Government R. & D. contracts are in effect contracts which follow an R. & D. effort of a private concern, and the question of who is going to end up with the patent rights is still not always clear.

Our basic position has been that it is in the public interest, particularly in the small business community's interest—to have full disclosure. So we will expect that problem to arise on certain contracts. I do not, however, think it will be too significant.

Senator DOMINICK. I realize you are just beginning, but have you had any response from industry itself on this proposed project?

Mr. MOOT. Mr. Maness has initiated discussions at the industry association level, and during our seminars and conferences it has been introduced for discussion with the small business community.

So far—although I might ask Mr. Maness if he has anything to add—the response has been good, but we have not been able to be explicit enough in terms of what we can do and when we will do it in order to get a very complete and comprehensive response.

Senator DOMINICK. So initially it seems favorable, but you do not really feel you have gone far enough into it to explore the full scope yet.

Mr. MOOT. We certainly think it is favorable enough to pursue it avidly, and we intend to do so.

Senator DOMINICK. To what extent would the originating R. & D. laboratory be able to perceive possible commercial uses? I ask you this for a very definite reason.

I talked to some people who have been engaged in Government R. & D. work in my own State, who are representatives of a rather large company. They came to the conclusion, over a period of time, that a company which was engaged largely in Government R. & D. had absolutely no conception of how to put together a commercial use of that same product—they did not know their management, their markets; they did not realize the usefulness of this in the general market.

Therefore, how accurate would they be in proceeding?

Mr. Moor. I think that is a good question, Senator. From our, perhaps optimistic, point of view I would point to two things:

NASA is, in effect, doing it now, through their regional dissemination centers, and it is working, and continuing to work.

They are making a determined effort to provide for commercial application.

The second point I would like to make is that much of this private sector research effort is associated with industry, and however Government-oriented the industry we are talking about—Defense contracts or otherwise—these are concerns that are now trying to diversify, for many reasons.

The effort towards diversification in the private sector will, in itself, lead to the application of research and for commercial use. So that I think that probably there is effort going along parallel streams that will aid our effort.

Senator Dominick. You have a feeling, then, if I interpret your answer correctly, that as you go along in this project, the ability to perceive potential uses will grow because of the need of the firms themselves to diversify?

Mr. Moor. I think that is right, sir.

Senator Dominick. What has happened on the so-called joint or pooling arrangement between small businesses to obtain R. & D. contracts themselves?

Mr. Moor. We have not been very successful, and I am sure that a good part of the blame should be leveled at us.

The problems, as we see them—first of all, it is in finding small concerns that are capable of doing the work. Second, finding concerns that can combine on a common ground. And thirdly, finding those concerns that will combine on a common ground.

There is a basic resistance, as is evidenced by the fact that small business is notoriously independent, and wants to retain its rugged individualism.

We, frankly, have not been very successful.

On the other hand, I do not think that we have explored every possible avenue along these lines. Mr. Maness is renewing his efforts in order to see if we cannot come up with a viable means or method of getting small concerns interested in getting together.

What we have done in a minor way is develop research profiles. We have taken small concerns which are doing research work, and we have assessed, from an inventory viewpoint, everything they can do—their manpower resources, and all of the work they have done. We have distributed the profiles of these individual concerns to Government procurement centers which are buying research, or are awarding or negotiating research contracts. We have made a few good contacts

with these concerns. As we move down this stream, there appears to be a possibility that we may do some combining of these companies, if we can get a common approach in a common area, and where their resources are complementary and fit into a total package.

I think that is about all I can really say at this moment, which quite frankly is not very much.

Senator DOMINICK. On page 5 of your statement you refer to only 18 companies participating in the NASA regional dissemination center.

Was this due to inability to get more of them interested, or was it that only 18 small companies were working in the space area? Were they just chosen out of the blue to participate in this?

Mr. MOOT. We picked on concerns to secure data from three of the RDC's, and we did it because the 18 we considered were the proper size for a pilot project. As the statement indicates, Senator, in effect we came out with an exact three-way split. As a result of the project, six concerns have continued as fee-paying members of the regional dissemination centers, because they believe that what they received from the centers was well worthwhile.

Another six of the 18 felt that the centers had worthwhile data, but it did not turn out to be the kind of data that they as individual concerns could use. Therefore, they have stopped the program.

The last six, or the last third of the pilot companies, did not consider that there was sufficient information there for them to consider even continuing.

Now, it is on the basis of this that we are continuing to work with NASA, and also through our seminars and workshops, in order to see if we cannot get a better interface and a better utilization.

This problem of preparing the data for small business concerns, and then making it understandable to the small business concerns is probably the stickiest and the most difficult of all of the problems involved in technology transfer. I do not think there is ever going to be any substitute for face-to-face counseling, or the individual explanation in an industry seminar, with an industry segment in a specific area. To do this, we need to work more closely with the repositories of the data, to see if we cannot shape it more meaningfully for small business, and then interpret and translate it. It is in this area that we would hope we would be working most closely not only with the Federal agencies, but with the State Technical Service agencies which we think hold a lot of promise in this program, as they evolve and develop.

Senator DOMINICK. Regarding these companies that thought the information was worthwhile but not sufficiently useful to them, and the other one-third who did not think there was sufficient information to warrant going ahead—were they reluctant because of lack of working capital to change over their own facilities, or were they reluctant because they did not have enough expertise in-house?

Mr. MOOT. Well, I should have prefaced my previous remarks by saying that the 18 in the experiment did not pay anything. They had a free chance to use this data.

I think it is primarily the same problem that was mentioned a little earlier.

It is a question of desire and capability to use the data.

Since the end of the experiment in the spring, there have been many

other members—small business concerns which have joined as fee-paying members with the RDC's. So that the six, the nucleus that did find it worthwhile, has been expanded into a larger group. It is this kind of a group that we like to work with and cross-fertilize to a larger segment of the small business community.

Senator DOMINICK. With RDC, are you trying to make possible commercial uses of inventions, or are we talking about making more efficient your in-house facility?

Mr. MOOT. I think it is both, sir.

This, of course, is a Federal agency which has undertaken to provide this data and to convert it for commercial application, and make it available to the entire business community.

Actually, I think some 40 percent of the current fee-paying members of the regional dissemination centers are small business concerns.

I believe we are making progress along this line.

Senator DOMINICK. Yes. But what I am trying to find out is when they give this information out to the firms that are fee paying members, is the information grouped around commercial uses of products, or is it grouped around efficiency in plant?

Mr. MOOT. I am going to ask Mr. Maness to see if he can supplement our answer on this.

Mr. MANESS. Mr. Chairman, I believe this project, as we have indicated, was a pilot project. The purpose was first to determine whether it is useful? Second, are there commercial applicabilities involved in this research and development? And third, can they become more efficient in their own operation?

We have found that a sizable number in the group that we utilized sometimes required special knowledge—as an example, a special technique in welding, or a special technique in metallurgy, and things of that nature. We were able to make them more efficient.

There are others who could diversify, go into something new, or make it applicable to something they are utilizing. And 30 percent of them were willing to go into this project—30 percent were reluctant, because they saw no present use for it.

We have over 83 companies today working with these centers. We find that some of them have the wherewithall and are paying up to somewhere around $2,000—it starts with $50 to $2,000—for the utilization of the service. We have found from the testing of these 83 companies that it has been very successful.

Senator DOMINICK. Recently I made a speech pretty sharply questioning procurement procedures, particularly in connection with denial of bids to small businesses despite their ability in some cases to make the low bid.

We had some help from SBA in one case. We have a case now with RCA where there was a specific amount paid to RCA to deliver drawings on an improved model of a walkie-talkie to the Defense Department.

We have yet been unable to find out whether the drawings were ever delivered.

We do have the information, which I am still checking out, that the drawings are being used in foreign countries.

We do not have information as to whether they have ever been available to any small business companies within our country.

And yet one small business company apparently anticipating what the development was going to be, bid $885,000 less than RCA, and still did not get the contract.

Now, where does the Small Business Administration come into this kind of a picture?

Mr. Moot. Well, sir, I think there are several ways we come into it.

One most important way is just being started.

We are, within the next few months, placing in the large Defense procurement centers, Small Business Administration representatives. As you know, several years ago this was discontinued.

One of the responsibilities of that Small Business Administration representative in the large Defense procurement centers will be to look at the non-set-aside areas, the areas that have not been exclusively set aside, or even partially set aside for small business, and to make sure that there is valid reason why these procurements should not be broken out for small business. Where there is valid reason therefor, he will see whether he cannot overcome it, through the transfer of technological data to the small business community in this particular procurement area—make the small business community capable of being a competitor in this particular area. That is one way—while we are doing this on a relatively small scale in terms of one procurement center, and sometimes covering several procurement centers—we have great hopes, where there is communication between the Small Business Administration and the small business community, as well as the procuring agency—in your case the Army—that we may develop a means by which the small business community will be able to bid successfully and secure technical data required to get awards where they are justified.

We do have our certificate of competency procedures whereby, in the illustration or the case that you cited, our certificate of competency procedure should be given recognition.

Senator Dominick. Well, I am sure we would get in a jurisdictional hassle of the first order if we tried to give one agency power of review and control over the contracting authority of another. But it does seem to me that somewhere along this line we are going to have to have something which will at least give the opportunity to small businesses to participate in this if they want to. To see small business knocked out, as I have seen one time after another, simply because the contracting officer knows the personnel of the bigger company better, because he has been to dinner with personnel of the bigger companies 150 times, seems to me to be the wrong way to approach it.

Somehow we have to work this out.

Mr. Moot. I would like to say this, Senator. I think it is our responsibility in either of those two cases—either in the case where the small business firm which has bid lower and does not get the award, although it is capable of producing—to see that he does get the award.

Senator Dominick. But he did not.

Mr. Moot. He should get the award if he has made his position known to the Small Business Administration—and I hope this will become easier and easier for him with our representatives at the centers. We should take the necessary steps. And we have the agree-

ment of the procuring agencies that these steps will be complied with.

Senator DOMINICK. In one case we even sent a wire of protest through the Small Business office in Denver. The Army called us a liar, and said the protest had never been sent even though we had your own regional officer say "I saw it being sent." The Army disallowed it because they said they never got the protest.

Mr. MOOT. I would be the last to say that all the cases work out perfectly, Senator. But I assure you we do take this responsibility very seriously, and I do consider it our responsibility. I think we are subject to criticism if we cannot work it out. It is also true if the Government has no technical data, and the procurement award is contingent upon their availability, we consider this our responsibility to see that this data is made available.

Senator DOMINICK. How do you do that? Suppose the small company says they can build it; suppose they have built this item; suppose they bid lower, and the contract is given to the big company; how do you reverse that?

Mr. MOOT. The very first step is a request by the small concern to the Small Business Administration.

Senator DOMINICK. That was done.

Mr. MOOT. All right sir. Then the next step—if it is a capability or capacity question—we make a plant survey of our own, and then we advise the procuring agency, whose award in the meantime has been held up, while we are making this determination—that the concern is capable or not capable. Either confirm its original finding, or we disagree with its finding.

Senator DOMINICK. This particular firm was the only one that had ever produced the weapon or piece of ammunition at all. No other company had been able to produce it. So I would think that would prove capability.

Mr. MOOT. I would think that would, too, sir.

As a matter of fact, I think I recognize the case without knowing all the details. I would be glad to use this as an example, if you would like me to put it in the record, as to how the procedure works.

Was this an Aberdeen procurement, as I remember it?

Senator DOMINICK. Edgewood Arsenal.

Mr. MOOT. I would be glad to, if you like, sir. I do not have all the details in my mind at the moment.

Senator DOMINICK. Well, I am going to keep after this particular case. But I use this only as an example of the problem. The attitude we received was that although the contract was given prematurely, and despite a protest, nevertheless they had given the contract, and once the contract was given, there was not anything they could do about it. This was the Army.

We took it to the Comptroller General. The Comptroller General said this was a factual deal, and since he was not technically competent; all he could do was what the Army said. Since the Army said the business was not capable, that was the end of it.

Mr. MOOT. I would be glad to look at the case. And I would be inclined to agree that if the Comptroller General said this was all that could be done on that particular case—that probably is the end. But

that does not mean we should not have learned a lesson from that case to prevent a like occurrence.

Generally speaking, we find that the procuring agencies are well motivated in terms of their desire to give business to small, qualified concerns. It is a question of getting the word to everybody at all proper levels.

Senator DOMINICK. You are more charitable than I am.

Mr. Moot, my staff brought several questions to my attention and I would be very interested in your response.

In opposing a centralized program for technology transfer, the Small Business Administration stressed the need to transfer how to use know-how as well as the actual transfer of the know-how.

How do you suggest that this is going to be done?

Mr. MOOT. Well, sir, I am not sure I have the final answer. Our proposal contemplates that, in addition to the data, there is need for technical consultation. This is the point I tried to stress in my statement. Face-to-face counseling, by knowledgeable people, is necessary in addition to the data. And as I mentioned, we have, in addition to our own in-house personnel, which is not too great—we have the service corps of retired executives—some 3,000 very talented business leaders, industrial leaders, engineers, and we can almost handpick in most areas the kind of people who need to provide the know-how that we are talking about.

We would likewise hope that at the State level, through the State Technical Services Act, that there would likewise be services available for interpreting and converting data into actual know-how for the small business concern. It is along this line that our thrust is aimed, Senator.

Senator DOMINICK. The SBA has taken the position that it is interested in a COMSAT-type approach to the problem. Most other agencies oppose that idea.

Now, how do you fit in your interest in COMSAT with your opposition to the centralized program? And what is your present thinking on COMSAT?

Mr. MOOT. Senator, I must confess I am at a loss. Whoever raised that question knows more than I do about the SBA's position. But it is a position I am not familiar with.

I would be glad, however, to research it and put an answer in the record, if that would be sufficient.

Senator DOMINICK. This was brought up in a question which was asked by the committee in our report—the reply being found on page 156 of our report entitled "Policy Planning for Technology Transfer." And under subsection 7, page 156, Mr. Boutin said, "We are greatly interested in the approach mentioned in the subcommittee's report, from the Congressional Record of October 17, 1966, namely, the organization of a federally chartered COMSAT-like corporation." And then he goes on to say SBA followed the British effort along that line. He does not go ahead and say anything beyond the fact that he is going to reserve judgment on a COMSAT approach, but he does say that he is very interested in it.

Mr. MOOT. May I, Senator, with your permission put that answer in the record? And I will try to be responsive, sir.

Senator DOMINICK. Fine. Thank you very much.
Thank you, Mr. Moot.
Mr. MOOT. Thank you, sir.
(The supplemental information submitted by Mr. Moot follows:)

SMALL BUSINESS ADMINISTRATION,
Washington, D.C., October 27, 1967.

Hon. JENNINGS RANDOLPH,
Chairman, Subcommittee on Science and Technology, Select Committee on Small Business, U.S. Senate, Washington, D.C.

DEAR SENATOR RANDOLPH: On September 28, 1967, I was privileged to participate in hearings before the Subcommittee on Science and Technology. I am pleased to present a statement supplemental to my statements recorded on page 232 of the Transcript of Proceedings, Thursday, September 28, 1967.

The supplemental statement which is enclosed describes this Agency's sustaining interest in Communications Satellite Corporation (COMSAT), and in the National Research and Development Corporation (NRDC).

Thank you for allowing me to present this supplemental statement for the Record.

Sincerely yours,

ROBERT C. MOOT, *Administrator.*

Enclosure.

COMMENTS ON COMSAT AND NRDC

We are reviewing the operations and the differences including the sources of funds between Communications Satellite Corporation (COMSAT) and National Research and Development Corporation (NRDC) because they are successfully exploiting new technology and discoveries.

COMSAT received its charter from the Federal Government. The Federal Government maintains substantial interest in the operations of the Corporation including the appointment of three Directors by the President, by and with the consent of the Senate. However, COMSAT is also a private corporation within the District of Columbia corporate law. It operates with money received by sale of stock. COMSAT is in the communication business and the equity owners look for profits from the operation.

NRDC describes itself as an independent public corporation. Its Board of Directors is selected by the Minister of Technology. Its capital resulted from a loan to it by the British Government. NRDC receives royalties under patent licenses and seeks a fair return on the risk investments it makes on projects. Its business is to promote the adoption by British industry of new products and processes invented in Government laboratories, in universities, and by private inventors. NRDC develops various types of patents and ideas to a viable commercial stage, then tries to license these ideas to others. At times NRDC invests money with industrial firms or individuals for the development of their own inventions and projects.

Senator DOMINICK. Dr. Astin, we appreciate your being here. The hour is getting later than we anticipated. Do you want to go through with your whole statement, or would you rather summarize it and put your whole statement in the record? You may proceed any way you want to.

STATEMENT OF DR. ALLEN V. ASTIN, DIRECTOR, NATIONAL BUREAU OF STANDARDS, WASHINGTON, D.C.; ACCOMPANIED BY DR. PAUL GROGAN, DIRECTOR, OFFICE OF STATE TECHNICAL SERVICES; AND DR. LAWRENCE KUSHNER, DEPUTY DIRECTOR, INSTITUTE FOR APPLIED TECHNOLOGY

Dr. ASTIN. I would be happy to put the statement in the record, summarize part of it, and respond to questions.

I have with me on my left Dr. Paul Grogan, who is Director of the Office of State Technical Services, and on my right, Dr. Lawrence

Kushner, who is the Deputy Director of the Institute for Applied Technology in the National Bureau of Standards.

The formal statement which I have submitted for the record outlines the various phases of activities that are carried on in the Department of Commerce relevant to the problems associated with technology transfer.

These activities are carried out in three units of the Department. First, the Patent Office—which deals with the protection of inventive right. Our Constitution authorizes the patent system, which gives limited protection to an inventor for a period in return for disclosure of his invention. Disclosure of information is a fundamental characteristic of the Patent Act.

Second, we have the Office of State Technical Services, which is aimed specifically at technology transfer. The third organization is the National Bureau of Standards, which is concerned with a number of problems associated with technology transfer.

I will enumerate some of these.

In general, we in the Department of Commerce look at our efforts in technology transfer as having three main characteristics.

First is the dissemination of technical information. Second is the provision of a framework of technological measurements and standards which facilitate the introduction of technology in our commerce. Third is an element dealing with the reduction of barriers to the transfer of technology.

Now, under the heading of dissemination of technical information, the primary activity is our Federal Clearinghouse for Scientific and Technical Information which was established as a repository for all of the federally generated technical report literature.

We process on the order of 750,000 orders a year in this Federal Clearinghouse responding to requests from industry.

One of the major deficiencies of the Clearinghouse is that it has no program at the present time for evaluating the information which is collected, filed, extracted, and disseminated. We fell that it is important to have an evaluation program, and we are hopeful that, through cooperation between the Clearinghouse and the Office of State Technical Services, evaluation of the data may be possible.

Senator DOMINICK. The comments you are making now are designed to cover the question of whether there is real quality in the available technology; is that correct?

Dr. ASTIN. That is correct.

Senator DOMINICK. What feedback have you received from the people who use this information on this point?

Dr. ASTIN. We get feedback indicating that a great deal of the information is valuable, but it requires considerable sorting to identify the valuable components.

It is our feeling that if we had a program of evaluating information in the Clearinghouse, we could increase significantly its usefulness to the Nation.

Senator DOMINICK. And you are proceeding that way now?

Dr. ASTIN. It is in our long-range plans; yes, sir.

Senator DOMINICK. But it has not started? This evaluation concept has not started yet?

Dr. ASTIN. No, sir; it has not started.

We do have one very important evaluated-data program in the National Bureau of Standards which was recently started at the request of the Federal Council for Science and Technology. This is our standard reference data system, which provides for collecting, sorting, filing, and disseminating evaluated quantitative information about the properties of matter and material.

This process involves searching of literature, abstracting quantitative information about properties from the literature, evaluating it with experts—it requires real experts to evaluate these data—assigning best values and confidence limits to these data, and then disseminating them.

This program is just getting started, but it will be of significant value in the total problem of transfer of technology when the standard references data system is available. What we will have is an organized file of data that product designers and product developers need in designing new or improved products. And it will be data that they can trust.

The program of the Office of State Technical Services is aimed primarily at identifying problems on a local and regional level. It is patterned after the very successful Agricultural Extension Service. It attempts to involve local talent, wherever possible, using local universities or research institutes for assistance in identifying problems. Solutions are suggested through exchanging and comparing information about successful solutions of the problems in one area of the country with those of another, collecting information, including the data in the Federal Clearinghouse; providing some evaluation on this; and then feeding it to the regional areas where it can be used to deal with local problems.

Senator DOMINICK. This report that you referred to from the Denver Research Institute, concerning the lack of utility of Government publications, refers, I gather, from the quote that you made, not only to the sheer mass of them, but also to the inability to evaluate them on a quality basis.

If I am right in that, why is your quality evaluation only in the long-range planning as opposed to present planning?

Dr. ASTIN. The evaluation part is a very important element of the program of the Office of State Technical Services.

Let me have Dr. Grogan tell you his views on this.

Dr. GROGAN. Mr. Chairman, the report being discussed at the moment has only come to our attention in the last few days. We are well aware of the evaluation need, and see that as an essential first step before material can be repackaged in a form which will be useful to smaller, less sophisticated industries.

We feel that the repackaging approach is authorized under the State Technical Services Act and is one approach to transfer technology that we seek to use.

In general the sequence operates from the level of a field service that coordinates its findings with three potential functions supported by our Office. These are the information, referral, and education services supported in the State programs.

Senator DOMINICK. The problem of communication seems self-

evident. If you say you only heard about this Denver research report 2 days ago, and yet the committee report referred to it in April of this year—so it was already out then. I am just saying here is another example of the sheer volume of Government publications—how do you keep up with them—even our committee report?

Dr. GROGAN. The report, as I understand, Mr. Chairman, was released in confidence several months ago. I believe it was released to the general public more recently.

Senator DOMINICK. If it was available to us in April, and we referred to it in a committee report, I would have thought it would have been available to you before that. But that does not mean that you necessarily happened to pick that one up. This is part of the problem, as I understand it. How do we figure out which ones to read and study, and which ones not to.

Now, are you still only pursuing this on a long-range policy, or are you pursuing it as a present plan to evaluate the information and documents available?

Dr. GROGAN. Our present plan anticipates the creation of substantial repackages of information based upon the general sources of literature—not only the Federal, but the private sector, and even abroad. A two-stage process is involved here. One would be to evaluate the literature that is worthy of putting into the repackage. The second would be to repackage the literature, effecting a very substantial reduction of a hundred to one or perhaps a thousand to one, so as to produce a document on a specific technology or particular problem of industry that can be used more readily by the industrialist, by the designer, or by the owner or manager of the business enterprise.

Senator DOMINICK. What you are saying, though, is that you are going at this right now. It is not just part of a long-range plan?

Dr. GROGAN. This is in our plan for fiscal year 1968, now going into operation.

Dr. ASTIN. The evaluation process, Senator Dominick, is a many-faceted one, and its full implementation has to be long range. In the Clearinghouse, for example, we are doing some, what I would call, cursory evaluation now. Specifically, we attempt to identify the areas of industry where a particular report might have value. The reports, then, are distributed to groups of industry people who have registered an interest in special topics. So, there is a degree of evaluation in the first cut—trying to identify where the information might be important.

The long-range goal for evaluation would be one of really abstracting and evaluating the total information in a report. This is a job even more difficult than our standard reference data program which we have been working on now for several years. We are still producing only a little over 10 percent of the evaluated data we think that program must ultimately produce.

We should say that the full evaluation of technological information is a long-range program with some aspects that are being taken care of now.

Senator DOMINICK. Go ahead, Doctor.

Dr. ASTIN. Our next major contribution is providing the framework for technological measurements and standards. This involves

identifying criteria that are important for technological products and services to meet in terms of performing useful functions, then devising test methods to permit the determination of conformance to these criteria, and finally assisting private standards-making bodies to write standards governing the level of performance and/or quality for technological products and services.

It is our view that this measurement capability which we seek to provide the Nation is extremely important in all processes involving improvements in industrial efficiency, and extremely important to facilitate the introduction of new or improved products and services.

It is particularly important that standards be written around performance characteristics. If they are, they tend to encourage creativity and innovation, because only the performance requirements are defined. This leaves open a whole range of methods by which the performance characteristics can be met through various designs.

These performance standards are in contrast to many types of standards which specify a particular design. The design standards tend to inhibit change or innovation or creativity.

So, we are pushing measurement technology to give the Nation a framework for the setting of performance standards.

Our final activity, the one of removing barriers to the transfer of technology, is carried on largely in our Office of Invention and Innovation. Here we attempt to identify factors which inhibit the introduction of new technology. These can be legal matters, procedural matters, and so on. One of the most important things this Office indulged in over the past year was assisting the Commerce Technical Advisory Board in writing an important report on innovation and its management. You will find summarized in this report many of the obstacles which do tend to inhibit innovation.

Briefly, we find that small business firms have many advantages over large ones, and vice versa. In general, the small business firm is more flexible. It usually is more anxious to build on a new idea, in contrast to larger firms who risk invested equipment and inventory when they switch to new products or services.

On the other hand, the entrepreneurial characteristic of the introduction of new technology is such that the risk factor is high. Here is where the large company has the advantage over the small.

Senator DOMINICK. Doctor, without trying to interrupt your train of thought, but to make sure we get this question in—on page 7 of your statement you say that you have 85 information centers in 41 States disseminating information through the State Technical Services Act.

Dr. ASTIN. Yes, sir.

Senator DOMINICK. SBA, I believe, said it had eight. NASA has nine. Defense has 20.

With this proliferation of centers, how does anyone know where to go to get the information that they are looking for, and what would you think about the idea of having regional centers instead of in the States?

I am not sure I would agree with that, but let's get your ideas on it.

Dr. ASTIN. Well, it is our view that there should be many types of centers. We feel first of all there ought to be at least one in each State.

There should be some dealing with regions, others dealing particularly with a specialized industry. An information center frequently will increase its usefulness directly in proportion to its depth of expertise and knowledge. Consequently the centers frequently have to be specialized in order to be effective.

Now, the establishment of such centers on a local regional basis is a major purpose of the State Technical Services Act. Accordingly, we consider that they should be one of the major mechanisms established for the dissemination and transfer of technology.

On the other hand, we welcome help on this problem on the part of these other agencies, and we have mechanisms for coordinating with them so that unnecessary duplication is minimized.

Senator DOMINICK. Off the record.

(Discussion off the record.)

Dr. GROGAN. First of all, the 85 centers represent nearly two per State in which we have placed money in fiscal year 1967. These centers are largely built on existing resources. Secondly, they are often specialized. For instance, there may be a center on ceramics technology in New York State and a center on textiles in North Carolina or Georgia. Thirdly, these centers are largely processors of requests for information, very generally handling the requests out of their own expertise and resources, or finally connecting, if you will, to national and regional information centers that are primary sources of documents and information that support the processing aspect that goes on in the technical service centers in the States.

Senator DOMINICK. In speaking of these 85 information centers you are not referring to separate Federal buildings stuffed with information stored in a computer, and delivered to anybody that wants it. You are talking about cooperating with an existing State institution, is that right?

Dr. GROGAN. Yes, Senator. Very largely they are built upon the engineering and scientific libraries of major educational institutions in the State. That is why we often have more than one in a State. They use the resources of that library which supplement its information resources with those of the Federal sources of information available from NASA, AEC, CFSTI, and others.

Senator DOMINICK. And you call that a center?

Dr. GROGAN. We call that an information center. And from the point of view of the industry in that State, that is the center where they turn for information.

We have one example in Wisconsin, where such a center is handling requests now at the rate of about 3,500 to 4,000 requests per year. The service has increased almost 10 times between fiscal year 1966 and its present rate of operation at the end of fiscal year 1967.

Twelve of the largest firms in the State use that center on a recurring basis. They account for about one-half of the requests that center is processing each year. Each of the 12 firms that I refer to employs 1,000 people or more in the State of Wisconsin. The remaining requests are generated by more than 100 firms employing fewer than 1,000 employees.

Senator DOMINICK. Go ahead, Doctor.

Dr. ASTIN. Our work on identifying barriers to the transfer of technology has identified two main processes in the stimulation of

innovation. One of these is associated with the buildup of small firms based on new ideas or new inventions which grow into enduring institutions. The second mechanism is the invasion of old, mature, and traditional areas by outside technology, the most obvious example being the invasion of the textile industry by the chemical industry.

We think these processes can be improved if we can do the following things: Support and encourage new small firms based on innovation. Improve information exchange among small firms; that is, information dealing with technology management, market analysis, selling—in short, the whole range necessary to the successful establishment and growth of a technically oriented enterprise. Expand the availability of risk capital for various stages in the innovation process. Strengthen the patent system or devise other mechanisms to enable small firms to protect long-term development risks. Ease the penalty of displacement by encouraging mobility—the ability to move from one region to another, one business to another, and from one skill to another.

This would mainly involve helping management to learn to identify the threats on the horizon in time to do something about them, whether this be diversification, retraining, or others.

This completes the summary of my formal statement, Mr. Chairman.

Senator DOMINICK. I appreciate it, Doctor, very much.

I am sure that the work that you are doing is of value to the economy as a whole, and to some of the small businesses.

Do you have any estimate of the number of small businesses which are making use of your services now?

Dr. ASTIN. We do not have the information concerning the Clearinghouse customers categorized this way. I think Dr. Grogan has some information about the State Technical Services.

Dr. GROGAN. In the one example I have cited, regarding the use of an information center in Wisconsin, approximately one-half of the total use is made by businesses employing fewer than 1,000 persons. This, of course, includes a great many more individual companies than those relatively few companies employing a thousand or more, that constitute the other half that have called upon the services of that center.

New York State reported that they have reached, in fiscal year 1967, some 8,000 individuals and 5,000 companies. They further report that the very substantial percentage—I do not have the percentage in this brief synopsis—but a very substantial percentage of the 5,000 companies they are reaching are categorized as small business.

Senator DOMINICK. Doctor, I wonder whether you or your staff could submit for the record the number of agencies which contributed to your collection of 53,000 reports last year, and a breakdown of those agencies.

Dr. ASTIN. The 50,000 number is the increment which is added to the number of titles in the report inventory each year. These reports represent in our estimate approximately 80 percent of the federally generated scientific and technical literature. We will give you the full list.

Senator DOMINICK. We would like to have the data on that, if you could give it to us.

(The information referred to, subsequently received, follows:)

Unclassified research and development reports added during fiscal year 1967 to collection of Clearinghouse for Federal Scientific and Technical Information

Agency or source	*Number of reports*
Department of Defense	18,000
Atomic Energy Commission	1,000
National Aeronautics and Space Administration	8,000
Other Government agencies [1]	5,000
Technical translations (from various Government and private sources)	19,000
Total	51,000

[1] Information concerning the number of reports contributed by each of these other agencies is not readily available; however, the following list includes the names of all agencies that made reports available during fiscal year 1967:

DEPARTMENTS AND AGENCIES CONTRIBUTING REPORTS TO THE CLEARINGHOUSE COLLECTION

Department of State:
- Agency for International Development.

Department of Interior:
- Office of Saline Water.
- Office of Coal Research.
- Office of Water Resources Research.
- Bureau of Commercial Fisheries.
- Bureau of Sport Fisheries and Wildlife.
- Geological Survey.
- Bureau of Mines.
- Bureau of Reclamation.
- Bonneville Power Administration.
- Federal Water Pollution Control Administration.

Post Office Department:
- Bureau of Operations.

Department of Agriculture:
- Forest Service.

Department of Commerce:
- Business and Defense Services Administration.
- Bureau of the Census.
- Economic Development Administration.
- Environmental Science Services Administration.
- Bureau of International Commerce.
- Maritime Administration.
- Patent Office.
- National Bureau of Standards.
- Office of State Technical Services.

Department of Labor:
- Office of Manpower, Policy, Evaluation, and Research.

Department of Defense.

Department of Health, Education, and Welfare:
- Food and Drug Administration.
- Office of Education.
- Public Health Service:
  - Bureau of State Services:
    - Community Health.
    - Environmental Health.
  - National Institutes of Health.
  - National Library of Medicine.
- Social Security Administration:
  - Bureau of Retirement and Survivors Insurance.
- Vocational Rehabilitation Administration.
- Welfare Administration.

Department of Housing and Urban Development.

Department of Transportation:
- Federal Aviation Administration.
- Federal Highway Administration.

General Services Administration:
- Property Management and Disposal Service.

Smithsonian Institution.

Veterans' Administration:
- Department of Data Management.

Small Business Administration.

National Science Foundation.

National Aeronautics and Space Administration.

Civil Aeronautics Board.

Federal Home Loan Bank Board.

U.S. Arms Control and Disarmament Agency.

National Capital Transportation Agency.

Water Resources Council.

Atomic Energy Commission.

Federal Power Commission.

National Capital Planning Commission.

Interstate Commerce Commission.

Federal Maritime Commission.

Federal Communications Commission.

Dr. GROGAN. Mr. Chairman, I have found the statement I was looking for with respect to New York, if I may provide it now.

This is from the annual report of New York State:

> Tabulations show that more than 8,000 individuals and over 5,000 companies received assistance through the New York State Technical Services Program in fiscal year 1967. Approximately 60 per cent of the officials were at the policy-making level, in management, while the other 40 per cent were in the supervisory and distribution levels. Significantly, a major portion of the users were from companies employing less than 100 persons.

Senator DOMINICK. Well, that is encouraging.

Doctor, I have just a few more questions here.

Why have so many States felt that elementary business education is necessary before State Technical Services activities can succeed?

Dr. GROGAN. The primary thrust of the State Technical Services Act is to encourage the application of science and technology in business, commerce, and industry. This is a very straightforward proposition when you are approaching a larger company that has established some depth in its engineering function. But when you approach a smaller company that does not have the functional depths, the decisionmaking responsibility often rests with one person as to how he is to apply science and technology. You have to talk in terms of the business-management approach to the problem—what will be his long-term benefits from this? what will it cost him to make the change from a relatively unsophisticated process to a more sophisticated process? how will this affect his ability to penetrate markets? what kind of employees will he have to acquire and train for this new approach? The responses we are getting from the States, particularly the smaller and less developed States, run along these lines: If science and technology are to be applied in these small companies, there is an educational job that has to be done upon the company management itself to show the benefits that can accrue from such applications. The educational approaches we must use to demonstrate the benefits of applying science and technology in business very often must deal in the "how" and "why" and not the "what."

Senator DOMINICK. Do you feel that the technology transfer effort is premature?

Dr. GROGAN. It requires, certainly, a greater than usual awareness on the part of the business manager that this is something that he must adopt to remain competitive in the future. He needs to be made more totally aware, and sometimes convinced, of the potentials in technology transfer.

Senator DOMINICK. Yes. But you were here when Small Business Administration officials were talking about the effort to have a technology transfer over into small businesses and other companies. Do you feel this effort is premature?

Dr. GROGAN. I do not think so, Mr. Chairman. Some examples that we have realized to date show that technology can be transferred into small business. It is a matter of patience, repackaging of the material, and working with the individual through a field service agent or someone who can gain his confidence, and spend time with him. It is a matter, then, of presenting the new findings and new material in a way that the small businessman can see its applicability to his enterprise.

We have an example in Utah where a man in the ceramics industry was importing a clay from the eastern part of the United States. He was paying some $100,000 a year in freight charges to have a clay with particular properties brought into his plant to make a high-temperature-resistant ceramic for use in furnaces. It was pointed out to him that the Japanese had been able to achieve good high-temperature properties, using clay similar to that locally available in Utah, simply by reprocessing the raw material with a chemical additive. The Japanese documentation was acquired, translated, and presented to the individual, who made a try at it. He is now successful in using a local clay, produces a ceramic with the same properties as before, and saves himself a hundred thousand dollars a year in freight charges. That man would not have made the transfer himself without what was involved there—the acquisition from abroad, the translation, the encouraging of further experimentation, the sitting down with him, looking at the potentials, and seeing if it could be applied to his enterprise.

Dr. ASTIN. I would like to make a brief direct response to your question.

It is our view that the process of technology transfer is so important for the efficiency, strength, and growth of our economy that it can never be too soon for all businessmen to become aware of it, and to seek to understand it and use it.

Senator DOMINICK. Do you feel that the State Technical Services Act is sufficiently broad to allow the promotion of business education which apparently is felt to be necessary in order to adequately get over the technology transfer?

Dr. ASTIN. Mr. Chairman, the State Technical Services Act specifies that there be an evaluation committee set up to make recommendations, to report to the Congress next year, concerning possible modifications of the act. This committee has just been appointed, and is in the early stages of studying the problem and developing its recommendations. I think it would be premature to answer your question until the committee has had a chance to study this.

Senator DOMINICK. Very well. Thank you.

Senator, I am going to have to go. I appreciate your letting me take the time.

Senator RANDOLPH. Senator Dominick, I am grateful. I am sure all members of the subcommittee are appreciative of your leadership this morning in the hearing.

Gentlemen, we feel that the testimony today has been highly important, and as we recap our estimate of that which has been done on Wednesday, September 20, Tuesday, September 26, Wednesday, September 27, and now, Thursday, September 28, we feel that the interest, both Government and private, has been developed in a helpful way for the subcommittee in connection with these technology transfer hearings.

I want to personally add my appreciation to that of Senator Dominick for the statements and your responses to the colloquies in which you have given us added information, which will be helpful.

I believe that we should give opportunity and have the record reflect that we might want to submit questions to you, Mr. Moot, Dr. Astin, and others, before the hearings conclude.

We will follow that procedure if it is necessary. There may be some matters we want developed. We would not call for you to return in formal hearing.

Also, it is the plan of the chairman of the subcommittee to have a further hearing on Thursday, October 12, and at that time we will think in terms of the witnesses being drawn, at least in part, from leaders who will be in Washington on October 10 and 11 for the State Technical Services meeting.

I believe I am going to participate in at least one of their sessions. So with the 4 days now and the anticipated fifth day, we think we are producing a record which will be helpful.

Before we conclude we will at this point receive for the record Dr. Astin's prepared statement, which will be printed in full in the record.

(The prepared statement of Dr. Astin follows:)

STATEMENT OF DR. ALLEN V. ASTIN, DIRECTOR, NATIONAL BUREAU OF STANDARDS

Mr. Chairman and members of the subcommittee, I am pleased to appear before you today on behalf of the Department of Commerce on the subject of the transfer of technology. This is a matter of considerable interest to the Department.

There are a number of activities in the Department which are aimed directly or indirectly at problems of technology transfer. These activities have already been described and included in this Subcommittee's Document No. 15, "Policy Planning for Technology Transfer." Accordingly, I shall describe them briefly and merely for the purpose of convenient review and reference. Additional details on organization, programs, projects, funding, etc. will of course be supplied to the extent desired.

The program of the Office of State Technical Services (OSTS) is an industrial and business analog of the highly successful extension service of the Department of Agriculture. OSTS seeks to encourage the earlier and more widespread adoption of new technology by actively bringing it to the attention of industry through State, regional and other programs. Educational institutions, State agencies, and nonprofit organizations serve as outlets and co-sponsors. This new program, signed into law just two years ago is already beginning to be of significant benefit to many of those small businesses with limited or no technological resources.

Among the activities OSTS supports are: *information services*, that couple user interests and needs with available sources of documentation; *referral services*, that help locate experts for consultation on specific problems; *educational services*, that create a greater awareness of new technology; *field services*, that determine the nature of needs at the local level and that match those needs with existing but unused technology; and *demonstration services*, that bring technology to the field in living form.

Our program for developing technological measurements and standards is centered at the National Bureau of Standards. In this field, the Bureau extends its measurement methods and technology to more complex entities, like manufactured products. It is the function of NBS to develop the technology required for this sort of measurement, rather than to make the measurements or evaluate the products themselves. The technological foundation that the Bureau provides in this work is the basis for many industrial and commercial standards, and is incorporated in building codes, safety codes, and so on.

The National Bureau of Standards' Clearinghouse for Federal Scientific and Technical Information is directly involved in technology transfer. It acts as a central collection and distribution center for unclassified scientific and technical information generated by the Federal Government. The Clearinghouse issues collections of abstracts, indexes, announcements of publications, and so on, to provide its customers with guides to the literature collection it has established. The customers can then order specific documents from the collection. In addition to collecting and organizing reports of completed research, the Clearinghouse indexes research in progress and provides referral service based on that information.

The Office of Invention and Innovation of the National Bureau of Standards provides advice to the Government on the impact Federal laws and policies—

tax, anti-trust, and regulatory policies, for example—are likely to have on the national climate for invention and innovation. It also assists inventors through services and programs—inventors' exhibitions, for example—in cooperation with the States.

The Patent Office, of course, administers the patent laws established by the Congress. It makes searches of existing technology to establish the novelty of patent claims and then issues the patents. There is a strong element of the informational function in the Office's activities. Our Constitution recognizes the importance of this function by granting protection for an invention in return for disclosure of information about it. The Patent Office "Journal" is an important source of information on new technology.

These organizational elements represent three kinds of activity related to technology transfer. They are—

1. Dissemination of technological information.
2. Providing a framework of technological measurements and standards.
3. Reducing barriers to the transfer of technology.

I will discuss these in sequence.

TECHNICAL INFORMATION

The handling of technical information is an extremely important—but extremely difficult—matter. The volume of literature being published is literally overwhelming. Each year, some 10 million scientific and technical articles, reports, and other documents are published throughout the world. These publications contain the results of world-wide research (not development) costing about 20 billion dollars a year, or an average cost of 20 thousand dollars each. Whether we consider the total or the unit cost of the published research we are dealing with a substantial investment that warrants our making every effort to derive the maximum benefit.

Compounding the problems resulting from the sheer volume of published literature is the fact that much of it is unevaluated, with the result that there is a wide range in the usefulness of the documents. Separating the good from the bad requires a real tour de force.

A recent report produced by the Denver Research Institute under NASA contract and entitled "The Channels of Technology Acquisition in Commercial Firms, and the NASA Dissemination Program," gave some illuminating insights into the problems of technology transfer through the dissemination of technical information. The report was based on a 14-month study of 60-odd firms in four industries.

Among the report's findings was the fact that few firms were actively trying to exploit the scientific and technical research supported by the Federal Government to the tune of about 16 billion dollars a year. Moreover, relatively little was being spent to make the non-space and non-defense manufacturer aware of what information was available.

The report goes on to say that:

"Government publications were not perceived as major channels for acquiring technological information. The variety and mass of government publications tended to overwhelm people and many simply were not familiar with potentially useful sources, and did not know how to screen and select relevant material. . . . Most individuals felt it too difficult to retrieve relevant material from the mass of government publications and indicated that they expected to learn of important government-developed technology through trade and professional channels."

How does one go about boiling down the huge mass of unevaluated information to a manageable volume of valuable information that is readily available to the potential user?

The first thing that has to be done is to identify the needs of industry and to match the pertinent technological information to those needs.

OFFICE OF STATE TECHNICAL SERVICES

One method to bring this about is being used by the Office of State Technical Services. The role of this office is to promote the use of science and technology by business, commerce, and industry. It does this by providing Federal funds to match funds contributed by the States and other public and private organizations participating in the program. The State and local people identify the specific problems to be attacked and bear the main burden of handling the transfer of

information required. This approach brings together human resources and available technical information in a program oriented to the specific problems of an industry or a region.

The Office has already demonstrated the success of this approach in several cases. Grants of almost $4 million were made to 41 States and $½ million for 16 special merit programs in fiscal 1967. With the matching non-Federal funds, this adds up to a $9 million program based on the total budget for the Office of only $5.5 million.

In addition to the virtually overwhelming volume of published output, OSTS has found that there is a significant amount of valuable and useful knowledge in the form of industrial and scientific practice or know how that is unpublished or undocumented. This information often is more current and more immediately useful than the typical R&D document. The matter of identifying and applying these unstructured resources, very often in the form of personal expertise, is a singular example of technology transfer in practical and understandable terms. Making use of this information is one of the major challenges faced by OSTS, and they are making progress on it.

The economic well-being of individuals, companies, whole industries, communities, States, regions, and nations alike are now seen to be increasingly dependent upon the rate of adaptation to the potentials of the newer technologies. There are numerous characteristic examples of how this rule applies. Examples can be cited for a given industry wherein the technologically most advanced competitor realizes a value added in manufactured product per man-hour that is some two or three times greater than the industry average and often five to ten times greater than the technologically most obsolete competitors.

The experience of the Office of State Technical Services points up that there is sometimes a need to approach the problem of technology transfer on a regional basis, where the boundaries make good economic sense, even if they don't match the political borders. The special merit programs authorized under this legislation permit this approach. In addition, several groupings of States are now either actively planning or are giving serious consideration to regional approaches to technical services despite the absence of financial incentives for such concerted action.

Qualitative analyses of what happened to create a Route 128 in Massachusetts and the Bay Area complexes in California and the economic benefits that they generate have led many people to the conclusion that several mutually supportive factors were at work, such as: 1) the longstanding excellence of local institutions of higher learning, 2) the corresponding stature of their faculties—which had the effect of attracting large numbers of potentially great faculty and graduate students, 3) leading, in turn, to major R&D work being performed there on behalf of governmental missions, 4) early adoption and acquired skill in employing interdisciplinary approaches to many otherwise difficult problem solutions, 5) the greater commitment and involvement of institutions and community, including financial resources, in the concerns of one another, 6) the spin-off potentials of the R&D being performed, and 7) the imagination and resources necessary to capitalize upon these potentials. Several programs are now under way for purposes of seeking to try to repeat these successes in other regions.

Example of relevant techniques permitted under the State Technical Services Act include:

Information Services. The State Technical Services Act aimed at realizing the secondary economic benefits from earlier research and development. OSTS operates on the premise that the technology can be transferred and the secondary economic benefits realized through appropriate information services. OSTS is speeding the flow of scientific and engineering information from a host of national resources to business and industrial users through 85 information centers in 41 States. In the simplest sense, these information services need do nothing more than furnish the inquirer with R&D information. But interpretation or repackaging of the information can make it far more useful to industry.

Referral Services. The particular expertise required to achieve results in the private sector with newly developed materials, processes, principles or phenomena held in the public domain, again, is believed to be a readily marketable and transferrable item through referral.

Educational Services. The spectrum of potentials in bringing primary research and development discovery to industrial practice may be broadened to include educational programs that create a greater awareness of these new potentials for

industry, including state-of-the-art experiences for the practicing professional in industry.

Field Services. The example of the Cooperative Extension Service in Agriculture demonstrated the efficacy of field services as being potentially useful in determining the level and the nature of need at the local level. The services of industrial liaison personnel can be most useful as they bring assistance to bear upon solving some of the immediate programs of local industry, thereby helping to build toward the potentials that modern technologies promise. That success can be achieved in the conversion of both thought and practice already has been demonstrated in a great many technology-based organizations. Others will be more likely to follow their example if these efforts can make their influence felt more widely.

Demonstration Services. Finally, the laboratory may be rendered portable and taken into the field, as it were, to demonstrate the success of the prototype that has been developed and proven by others.

FEDERAL CLEARINGHOUSE FOR SCIENTIFIC AND TECHNICAL INFORMATION

Moving now to another activity, the Federal Clearinghouse for Scientific and Technical Information, also in the Department of Commerce, plays an important role in making technical information available to industry.

The Clearinghouse is the first step towards giving industry one single point of contact for all of the unclassified, Federally-generated, scientific and technical report literature. It has gone a long way toward that goal, and eliminated much duplication of effort. It has taken over the functions of several separate, sometimes overlapping agency distribution centers.

Last year, the Clearinghouse processed 52,000 reports into its collection and distributed over two million document copies.

Of course the Clearinghouse has a well-developed classification and indexing system which helps the customer locate material relevant to his interests. But more interesting is the effort the Clearinghouse makes to reach its customers right in the area of their interests. The Clearinghouse invites the customers to register their interests. The Clearinghouse invites the customers to register their interests in terms of a list of 57 industrial categories like acoustics, adhesives, automation, and so on. The customer then receives what the Clearinghouse calls "fast announcements" of all documents they collect in the selected fields. You can see that this approach is much more efficient for the customer than his having to wade through abstract collections and indexes which contain only a small amount of materials of direct interest to him.

The Clearinghouse also tries to speed the flow of information by making up special interest packages for industry associations, State and regional development groups, universities, and such. In this way they can cater to the specific mix of industry in a limited area.

The critical need in dealing with the vast outpouring of technical literature is to select the useful documents and critically evaluate the information contained therein. The work of the Office of State Technical Services and the Clearinghouse is aimed in this direction. However, a more complete system for doing this efficiently and economically needs to be worked out particularly for the evaluation problem. We have a good precedent to go by in the system set up to handle one kind of information—numerical scientific data, the numbers that give the physical properties of matter and materials.

NATIONAL STANDARD REFERENCE DATA SYSTEM

In 1963, the Federal Council on Science and Technology recommended the establishment of a National Standard Reference Data System. Coordination of data compilation, evaluation, and dissemination was the aim—to avoid costly duplication, waste, and ineffectiveness. Responsibility for this coordination was placed in the National Bureau of Standards Office of Standard Reference Data.

The Office identifies the data needs of the scientific and industrial communities, locates the centers of expertise in the various scientific disciplines, and, through contracts and other means, encourages the scientists in these data centers to locate data in the literature, critically evaluate the findings, identifying the most reliable or "best values," and to publish their results in compilations available to the scientific and technical community.

A similar approach might be appropriate for the treatment of more quantitative technological information as well.

INFORMATION SYSTEM STANDARDS

We found that in the standard references data activities standardization was essential if we were to avoid chaos. The same is true of information handling systems in general. Standards for information handling systems would cover indexing, abstracting, cataloging, computer encoding of text, equations and drawings. Standards developed in this country would have to be compatible with those of other nations, making a set of international standards essential.

Some basic standards for international information interchange have been proposed, particularly for computer acquisition, storage, and retrieval of information. As Dr. Chalmers W. Sherwin put it, "Just as the size of track gauge standardized the railroad industry, international agreements on the information interchange media, computer tape size, number of bits, and other basic standards would make it possible for major abstracting services to begin communicating with each other."

TECHNOLOGICAL MEASUREMENTS AND STANDARDS

The second major kind of activity having an impact on the transfer of technology has to do with technological measurements and standards, which provide an important framework for effecting that transfer. While this framework function is extremely important, its nature is not well understood by the general public.

Measurement is the foundation of all research, technological development, production, and commerce. I think we are just coming into full realization of its importance in the area of high technology products. In some fields, we are just beginning to be able to make the measurements we need—in computer development, for example. The National Bureau of Standards is active in all aspects of technological measurements, both established and emerging, in order to provide a basis of measurement standards, tools, and techniques.

Measurement is fundamental to the evaluation of technology. Unless the manufacturer can measure the performance of a manufactured item, he has no way of knowing whether it is an improvement over previous models or not. Furthermore, with such measurements, he can not only satisfy himself of the product's worth, he can prove it to others. So you can see the tremendous impact the ability to measure has on the decision making process in industry and commerce. Without that ability, the manufacturer is more or less flying blind.

The ability to measure the properties and performance of manufactured items is also primary to writing standards for these products. A standard which specifies the design, quality, performance, and so forth of a product is not meaningful unless we can, through precise, scientifically sound measurements, show that a given sample does or does not live up to that standard. In this country, of course, this standards making procedure is a voluntary one. Some 400 organizations, including professional, trade, and industrial groups, private standards-making bodies, and Federal, State, and local governments to have generated about 13,500 standards which influence commercial transactions.

Without these and other standards there would be chaos in the marketplace as well as in all levels of manufacturing. But standards can inhibit as well as encourage commercial activity by stifling the development of new products and services. Thus if they are to stimulate innovation, they must not specify the *design* of a product but rather its *performance*. However, this is not to downgrade the importance of design standards in cases where uniformity of product design is required for inter-changeability.

As the complexity and technical sophistication of products increase it becomes more difficult to define those characteristics of a product that most significantly measure its performance. For example, compare the task of measuring the performance of a radio of 20 years ago with that of measuring the performance of a home entertainment center which contains stereo sound, AM-FM radio, and color television—and the subjective response of man himself. We are now faced with determining the performance criteria of systems as well as simple products.

Technological measurements and standards based on performance criteria are important spurs to the transfer of technology. They provide a language for communication between producer and user. They can also be regarded as one of the "valves" which control the flow of new technology from R&D to the manufacturer and from one sector to another. Rigid, design-oriented standards tend to maintain a static level of technology. On the other hand, performance-oriented standards

not only permit but stimulate the transfer and application of technology and thereby healthy competition in the development of new products and services.

Take a classic example—if I define a wall as something made of two-by-fours set a certain distance apart, covered with a specific material, and fastened by so many nails, I tend to freeze the technology of wall-building. On the other hand, if my standard defines a wall as a structure which will support so much load, offer so much insulation to heat or sound, so much resistance to the spread of fire, and so on, I open the door to the transfer of technology and to innovation. The builder is free to take advantage of new technology and make the wall out of any materials and in any configuration he desires. The only limitation is that what he comes up with has to fulfill the performance requirements.

Performance criteria, as well as other standards, are the great equalizer. With the confidence that his products meet established criteria, the small businessman can compete more equitably and effectively with the large companies. He can choose to compete on the basis of price, on the basis of quality or on the basis of novelty. Moreover, he can share in the manufacture of components of a system being built by a prime contractor, knowing that his parts will fit and be compatible with others when assembled.

The technological measurements and standards program at NBS covers such fields as building technology, automatic data processing, electronic technology, systems analysis, motor vehicle safety, engineering materials, industrial and consumer products.

REMOVING BARRIERS TO TRANSFER

The third and last broad topic I would like to discuss has to do with the role played by invention and innovation in the transfer of technology. The key point here is that the barriers to technology transfer and to innovation are not primarily technical in nature but rather entrepreneurial. Moreover, this applies not only to the so-called technology gaps within our borders but between nations as well.

The transfer of technology is an integral part of the innovative process. This process includes a number of inter-related activities, ranging through research and development, invention, product or process design, manufacturing, and marketing the new product or applying the new process. Technology transfer takes place at all points in the innovative process, and the speed and penetration of that transfer greatly influence the rate of innovation.

The conditions for technical innovation include—

1. A clearly perceived need.
2. A source of ideas, information, insight, and experience.
3. Resources to bring the product or process into use.

If there is one inherent attribute of innovation it is creativity. It takes a creative mind to conceive the invention; a creative mind to perceive the market for the invention; a creative mind to adapt manufacturing, marketing, and management techniques to fit the new idea.

And there is one outstanding characteristic of creativity—it is a personal, individual phenomenon. It is not a corporate attribute, and if it is found in group activity it is not a property of the group as a whole but of the individuals in it. Hence—despite the vast sums spent for R&D by large corporations (about 90 percent of industrial R&D is performed by the 20 largest manufacturers) it comes as no surprise that small firms and individuals account for a high percentage of inventions.

The principal sources of technical innovation are—

1. Small firms and independent inventors.
2. The in-house technical resources of large companies.

The central problem in both cases is entrepreneurial. The barriers to innovation are not due to lack of technical resources or ideas, but to difficulties in bringing the invention into commercial use. For example, in a typical distribution of cost involved in successful product innovations, 5–10 percent goes for research, development and invention; 10–20 percent to product design; 45–75 percent to tooling up and starting manufacture; and 10–25 percent for marketing start-up expenses.

The problems typically faced by small firms and independent inventors include—

Lack of sufficient risk capital.

Inability to protect investment either through the patent system or through saturating the market in a short time.

Insufficient information about the potential demand for the product.

Insufficient resources or skill in marketing the product.

Those faced by large firms include—

Threat of technical innovation to existing investment in capital equipment.

Commitment of management and workers to present processes and organization.

Lack of communication, and therefore lack of cooperation, among specialized departments in the firm—marketing, R&D, fiscal, management.

The need in large, long-established firms to learn new entrepreneurial skills.

Since a significant number of inventions conceived by independent inventors are offered to large firms for manufacturing and marketing, the problems of the large firms often become those of the inventors.

I would like to go into a bit more detail about the inertial resistance of established firms to technological innovation.

The very nature of a mass production economy makes innovation both costly and risky. Corporations build up expensive production facilities, armies of trained service technicians, established sales organizations, large inventories of spare parts, specialized management techniques and so on. If innovations are to be introduced, an effort is made to fit them into current marketing, production, maintenance, and servicing procedures.

The larger the corporation, the greater the influence of these inhibiting factors. Moreover, the inhibition is compounded where the firm is already highly successful. The feeling is "why rock the boat?" This explains why technical innovation in an industry so often stems from outside sources, by invasion, so to speak. Instant photography was invented by Edwin Land, not by the photographic industry. The chemical industry rather than the soap industry introduced low-suds detergents. The chemical industry, not the textile industry, pioneered synthetic fabrics. And there are many other such examples.

What can be done to solve some of these problems? The Office of State Technical Services is doing much to bring interested parties together to consider jointly the technical, economic, and entrepreneurial aspects of technology transfer and innovation.

The Office of Invention and Innovation, is aiding the individual inventor and helping to improve the national climate for innovation.

The patent policies and practices of the United States have been carefully examined by a Presidential Commission, the Patent Office and others, with the view of making recommendations for change or improvement that will encourage invention and innovation.

In a more general vein, it would appear that the most promising opportunity to stimulate technological transfer and innovation is to improve the existing processes of innovation in U.S. industry. The two main processes are—

The start-up of new small firms based on inventions, some of which survive and grow into viable establishments

The invasion of old, mature, traditional areas by outside technology, with the resultant displacement of old firms, industries, geographical regions, and workers.

These processes could be improved if we can—

Support and encourage new small firms based on innovation.

Improve information exchange among small firms—information dealing with technology, management, market analysis, selling—in short, the whole range necessary to the successful establishment and growth of a technically oriented enterprise.

Expand the availability of risk capital for the various stages in the innovation process.

Strengthen the patent system or devise other mechanisms to enable small firms to protect long-term development risks.

Ease the penalties of displacement by encouraging mobility—the ability to move from one region to another, from one business to another, and from one skill to another. This would mainly involve helping management to learn to identify the threats on the horizon in time to do something about them, whether this be diversification, retraining, moving, or other.

Senator RANDOLPH. Again, I thank you gentlemen.

That will be all.

(Whereupon, at 12 noon, the subcommittee was adjourned, to reconvene subject to the call of the Chair.)

TECHNOLOGY TRANSFER

THURSDAY, OCTOBER 12, 1967

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE AND TECHNOLOGY OF
THE SELECT COMMITTEE ON SMALL BUSINESS,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10:10 a.m., in room 1202, New Senate Office Building, Senator Jennings Randolph (chairman) presiding.

Present: Senator Randolph.

Also present: Blake O'Connor, professional staff member; Daniel T. Coughlin, minority counsel; and Richard A. Carpenter, Legislative Reference Service, Library of Congress.

Senator RANDOLPH. Good morning, ladies and gentlemen.

We continue the hearings of our Subcommittee on Science and Technology of the Select Committee on Small Business.

We are fortunate that the witnesses today are men who were, I believe, innovative in their programs and the organizations they head are resourceful. It is felt that the contributions by Angus and Allen Peyton, Mr. Larson, and Dr. Hedden will be helpful.

There is a list of discussion questions I will submit for the record that will be covered in today's hearing.

(The information referred to follows:)

DISCUSSION QUESTIONS FOR STATE TECHNICAL SERVICES REPRESENTATIVES

1. The necessary interest within a receiving business to make technology transfer work and to create a demand for Federal transfer efforts may be dependent on the confidence in the quality of information. In your experience with referrals, what is industry's opinion of government technology? How complete is the coverage of a given field? What is the wheat-to-chaff ratio? In what ways could quality and completeness be improved?

2. Feedback from users or prospective users of Federally derived technology is important in judging the success of present programs and comparing different approaches. What can you offer the Subcommittee on this point?

What techniques would you suggest for obtaining more meaningful feedback?

3. The question of the number and location of dissemination centers has been raised. What are your views of incentives for a regional approach? Should centers specialize as to field or industry? Describe the elements of an optimum dissemination system some years in the future.

Senator RANDOLPH. I believe we will have Angus Peyton, the commissioner of commerce of the State of West Virginia, lead the panelists in a discussion on the subject which has been given 4 days of hearings, today being the fifth day.

So, Angus, would you identify yourself for the record and proceed?

STATEMENTS OF ANGUS E. PEYTON, COMMISSIONER, DEPARTMENT OF COMMERCE, STATE OF WEST VIRGINIA, CHARLESTON, W. VA.; ALLEN PEYTON, DIRECTOR, STATE TECHNICAL SERVICES, STATE OF WEST VIRGINIA, CHARLESTON, W. VA.; ROBERT W. LARSON, DIRECTOR, STATE TECHNICAL SERVICES, STATE OF NEW YORK, ALBANY, N.Y.; AND DR. GREGORY D. HEDDEN, DIRECTOR, STATE TECHNICAL SERVICES, STATE OF WISCONSIN, MADISON, WIS.

Mr. ANGUS PEYTON. My name is Angus E. Peyton. I am commissioner of commerce for the State of West Virginia. I am appearing here today as a representative of one of our small States in this country, the State of West Virginia, and I am appearing here in my functional capacity as commissioner of commerce and head of the designated agency for our State Technical Services.

I might say that the department of commerce in my State has been the repository, by edict of Governor Smith, of many of the social and economic programs of the Federal Government, in order to coordinate and relate these in a usable fashion in our State.

I say this by way of off-the-cuff remarks, because I think it is very important that we have a coordinated effort of Federal and State programs for social and economic development throughout the United States, and on the basis of regions.

As I understand, the purpose of this hearing is to aid in establishing future policies for Federal technology transfer. Therefore, I would like to first tell you what we are doing in West Virginia.

Before Public Law 89–182, the State Technical Services Act of 1965, was passed, we had established in the department of commerce a science and technology unit, one of the responsibilities of which was to encourage State business and industry to take advantage of new technology. This was a very small unit in our department, and we use it in close conjunction with our industrial development, and we found that we had neither the money nor the expertise that was necessary to do the job.

We were quite pleased when the State Technical Services Act was enacted into law. We knew that it was not a panacea, but we felt that it would enable the State government of West Virginia, to increase its efforts in assisting existing business and industries.

Shortly after passage of the State Technical Services Act, Gov. Hulett C. Smith named the department of commerce as the designated agency to coordinate and administer programs under it.

The department applied for a $25,000 planning grant, which was received in early 1966. A 5-year plan was prepared in accordance with provisions of the act. This plan and an annual program for fiscal year 1967 was submitted to the Office of State Technical Services, U.S. Department of Commerce, in June 1966.

We felt that for a technical services program to be effective it would have to be geared to the needs of State businesses and industries, particularly small- and medium-size firms which had not kept pace with the state of the art and could not afford research and development staffs. We considered several approaches and, after much study and consultation with businessmen and educators, decided to place em-

phasis on a person-to-person approach. By so doing, we could isolate problem areas and determine needs of business and industry.

The fiscal year 1967 technical services program was not approved and funded by the Federal Government until December 1966. Therefore, this program did not get underway until calendar year 1967. Fortunately, we did have the staff or board paid by State general funds, and we were able to move very rapidly.

Participants in the program are West Virginia Department of Commerce, both as designated agency and qualified institution; West Virginia University, Morgantown, W. Va.; Concord College, Athens, W. Va.; Technical Consultants, Inc., Huntington, W. Va., a nonprofit development corporation; and Bethany and Shepherd Colleges, Bethany and Shepherdstown, W. Va., respectively.

The department of commerce, West Virginia University, Technical Consultants, Inc., and Concord College are each assigned specific geographical areas of responsibility within the State. Bethany and Shepherd Colleges are to participate by conducting seminars.

The West Virginia Department of Commerce, as the designated agency, is responsible for planning, administration, and coordination. Operating projects include regional public information conferences, field visitation programs, information dissemination services, technical reference service, seminars on technical operating problems of small business firms, and business management institute.

The department of commerce inaugurated the technical services program by conducting regional public information conferences in Parkersburg, Fairmont, Bethany, Charleston, Beckley, Bluefield, and Huntington. Their purpose was to acquaint business and industry with the State technical services program.

Chambers of Commerce and educational institutions in the area where the conferences were held cooperated to the fullest extent in planning, coordinating, promoting, and conducting these conferences.

Two hundred twenty-five persons, representing 138 companies, attended the conferences; and it is felt that they did much to acquaint business and industry leaders with the purposes of the program and the services available to them.

Field visitation projects were included for West Virginia Department of Commerce, West Virginia University, Concord College, and Technical Consultants, Inc. Participants involved in these projects have visited approximately 200 State firms. These visits have served to acquaint owners and managers of business and industry with the technical services program; and have made them aware of sources and utility of new technical information concerning products, processes, services, equipment, and procedures; and have identified areas of interest and common problems.

Initial field visits were made to a cross section of West Virginia business and industry; however, beginning July 1, 1967, field visits have been concentrated on one industry grouping at a time. This aids in identifying common problem areas and enhances the capability of the designated agency and participants in problem solving and transfer of technology. We felt this was very important, to try to look into the particular common problem at one time with our own staff. The first industry to be concentrated on was major SIC group 35, machin-

ery, nonelectrical. We found in our State that such large defense corporations as FMC and others were having difficulty in getting subcontracts in their State. They had to go out of State, because many of the subcontractors in the machinery, nonelectrical group did not have the expertise, because for the most part they were tied to the mining industry. And they could not find the people that could work to specifications necessary for defense contracts.

The program has been operating such a short time that it is not possible to determine direct benefits resulting from this project. However, it is our considered opinion that firms visited have a better understanding of the program and that this will bear justifiable results later. It has also resulted in identification of areas of interest to be used in selective information dissemination.

Information-dissemination projects were included in the approved program for West Virginia Department of Commerce, West Virginia University, Concord College, and Technical Consultants, Inc. Institutions conducting these projects were to counsel with individuals with firms who indicated special interests and assist them in searches for specialized information; respond to request for technical information by performing, or having performed, searches, retrieval, and dissemination; or referring requester to probable sources of needed information.

Information has been disseminated primarily on a request basis. There has been a limited amount of selective information dissemination and, as interest profiles are determined, a current awareness program will be instituted on a selective dissemination basis. In fact, information is now being gathered and reports are being prepared about such innovations as electrostatic painting; ultrasonic machining; new developments in close-tolerance machining; electrochemical machining; and chemical milling. These are all things that are necessary in our State to do our industrial complex.

Senator RANDOLPH. Let me ask a question at that point, Mr. Peyton.

You speak about the information being gathered and the reports being prepared. Now, how do you do this?

How is it made practical and useful?

I would want you to know that we are interested in from what sources the information comes.

And how do you assure a certain degree of completeness and quality in that material which you speak of in your statement?

Mr. ANGUS PEYTON. We are attempting to get this information from all the sources that are available, such as NASA and many of the publications. We have people on our staff that read this material as it comes in to us, and they are attempting to catalog it and build a library and are attempting to extract information that we know has a specific impact on the industries who have come to us and asked for problems to be solved. We take this and try to translate it into usable form and disseminate it on a person-to-person basis to these industries.

Now, we do not have variety that I think is necessary, nor do we have the computer setup. Even so, we feel that we can retrieve this information. We are only in the embryonic stages on this, and I think it is going to take us a long time, working hard, to develop this information so that we can put it out in report form.

But I would like to say that the most important thing is not the reports that we get. This only comes to us so that we can in turn translate it and put it in a communicable form so that we can get it to our small-business people. They do not really understand these reports, as I understand. They look at them, but they are volminous and technical, and so they mean very little to the people that need this. So what we are trying to do is take this information which we are gathering and translate it, put into words, if you will, so we can translate this to the small man, the small-business people that need it, and this can only be done on a person-to-person basis. If we send out these reports, we are not going to get any place.

Senator RANDOLPH. Do you have a comment, Allen, on that point?

Mr. ALLEN PEYTON. I agree with the Commissioner on this, about the sources of information. We not only use our Government sources—as the Commissioner pointed out—reports do not transmit technology, it takes people to do it. We also use industry. We get good support, of course, from equipment manufacturers, because it is in their interest to help us in these matters and, as the Commissioner said, this is the tact we are taking.

We are approaching it on a person-to-person basis. When we were talking about making these reports, they will be packed down in a form which is not only understandable but also usable to industry in West Virginia.

Senator RANDOLPH. At this point, I would like to comment, not with any finality but to make a suggestion which perhaps all panelists could comment on now or later.

We speak about the job being done in West Virginia. So there may be a reason why that job should be done on a regional basis rather than a State basis. I think in terms of North Carolina or some other State like Indiana. What is your feeling about the job other than these cutoff jobs on this subject?

Mr. ANGUS PEYTON. As you know, I am an opponent of regionalism, particularly in West Virginia, where we do not have the resources and we do not have the manpower to do the job on a county-to-county or city-to-city basis. I feel this is true also on a State basis. I think that when you have a specific problem you must try to find out the area of that problem.

For instance, North Carolina, as you know, has a great textile complex. We have very little. Our basic industry has been coal mining, steel, the production of steel, aluminum, and the chemical industries. These have specific problems that may not relate to what North Carolina is doing, or possibly parts of Ohio.

But there is a regional area which I feel could very well benefit from the tremendous cost, say, of preparing a library or getting the expertise that is necessary, that would be very helpful, and I do believe that this could be done on a regional basis much like the NASA program is, and we would like to be a part of it.

Senator RANDOLPH. I suggest that others comment.

Mr. ALLEN PEYTON. I certainly agree with this, Senator. Of course, I realize, and I think to be pragmatic about it we have to realize that we have to overcome a lot of parochialism, and so forth; but I do feel that we are wasting facilities, we are wasting manpower, we are wast-

ing funds, and of all of them, I think manpower is probably the worst, because good qualified people are certainly hard to come by.

Senator RANDOLPH. Thank you. Would you care to comment, Mr. Larson?

Mr. LARSON. In New York State we happen to have remarkably good library resources and information sources in the 22 institutions that are in our program and other places like the New York Public Library.

I think that the New England experience has shown that there is great difficulty in establishing regional programs on a cooperative basis, and we have decided that we might better go ahead in New York State and develop what cooperation we can with the surrounding States on an informal basis rather than establishing a formal project.

Senator RANDOLPH. Thank you, Mr. Larson.

Would you comment, please, Dr. Hedden?

Dr. HEDDEN. Thank you, Senator. I have a few comments on that point.

I also feel that there is an enormous advantage in the economy of scale in some aspects of a regional program. And I think, too, in that case, that certain specializations might mean a great deal, such as is available at Battelle Memorial Institute, where they have various specific libraries and projects directed to subject oriented material.

I think, however, that we have to look at one other feature and that is the user end of it, which still needs a great deal of help and interpretation. So that if we had major regional dissemination centers, we would still have the problem of getting this usably into the hands of the smaller company.

But I, again, think that this can best be done on a very local basis.

I really think there is one analogy here which just occurred to me this morning, between the areas of science and engineering and that of law. I know that in spite of our vast knowledge of law in the country, if I had a legal problem—and I am not an expert—I will have to turn to my local lawyer for assistance. I think our smaller companies are very much in the same situation when it comes to the more advanced areas of technology, they do not have the experts at their disposal within the firm. And we still need this local area contact which can do the final transfer. It is pretty much on a personal basis.

In other words, I am saying that I am for the regional effort, but we do have to consider a lot of local effort.

Senator RANDOLPH. I am inclined to believe, Dr. Hedden, that we can't do away with certain overlapping, and yet there is this more or less what you call the local approach, the individual problems of certain areas that must be given in depth and scope the coverage that might not be in the overall necessary for other States. Is that what you are saying——

Dr. HEDDEN. Yes, sir.

Senator RANDOLPH. (continuing). In effect?

Dr. HEDDEN. Yes, sir.

Senator RANDOLPH. That there needs to be this dipping-in, in a certain State on, let's say, a certain problem.

Dr. HEDDEN. Yes. As far as problem-oriented technology is involved, it may deal with resources—I do believe that there are many problem-

oriented situations within the States that they must look at on their own. And this would be very useful.

Senator RANDOLPH. Thank you.

Mr. Peyton, would you comment?

Mr. ANGUS PEYTON. One of the resources we use in disseminating information in a usable form is IBM. We have put on IBM cards addresses to people that we know need this information. And our department takes information and puts it into a service we call Technical Services Newsletter, which we distribute to about 3,500 industries and people who are particularly interested in the particular problem.

Senator RANDOLPH. I think this is a good service. I happen to know of its results in some cases.

Mr. ANGUS PEYTON. Thank you, sir.

We find, Senator, that somehow you have got to get this information out and it has to be put out in a language that they can understand. And if we would merely take reports from NASA or other industries and send these out, they are going to go into the wastebasket. What we try to do is digest and put these into readable form, to encourage them to read them better, and if they pick up a problem, they can call us directly.

We did operate a seminar project called "Technical operating problems for small business firms"; however, I was quite disappointed in the results of this, not from the program itself but from the attendance and the number and quality of the people that attended it.

And I think that we have a real problem today, Senator, in that so many seminars are going on and so many meetings are being called, of getting businessmen to participate to take care of their own businesses. Seminars are a wonderful thing, but I think that we are finding more and more that the big thing is eyeball-to-eyeball and person-to-person contact. First, we have to acquaint people with the idea that we do have the service, we have our seminars, we have our conferences, but I think we are going through that phase now, and we are ready to move into the real important part of it. And that is trying to get this information directly to those who need it.

Regarding the funding of the State technical services program, we believe that the floor plan of the State technical services used in allocating funds frankly discriminates against small business with low technological bases such as ours. We recommend that they devise a formula which takes into consideration all the factors allowed in the State Technical Services Act instead of considering the population alone, such as they are now doing.

Senator RANDOLPH. Mr. Peyton, do you have a specific formula that you might suggest?

Mr. ANGUS PEYTON. We are working on this formula. We have not come up with one, but we have several suggestions we might make.[1]

Senator RANDOLPH. We would be pleased to receive any information on this subject. And you might even, if you have it, at any reasonable time, include it in an answer that you would give to the question that I have asked.

Mr. ANGUS PEYTON. Secondly, our administrative costs do not rise in direct proportion to our operating costs.

[1] Retained in committee files.

Conversely, they are not reduced in direct proportion to reduction in operating funds. Therefore, the effect of such funding is to increase the ratio of administrative costs to operating costs.

We recognize that in attracting the expertise that is necessary in this program it is difficult for us to compete with large States that have available money. It is just as important that we attract in our State, or any State, top-quality men. I would rather have one good man on a good salary than three who do not have the necessary ability to do the job.

There are many different ways of transferring technology, we know. When you get into this proposition I made earlier, we were very definitely of the opinion that this can only be done on a person-to-person basis, which we are trying to do now. We are limited. We have had direct success with this approach.

It also can be done by, as I said earlier, conducting seminars on technical subjects which the designated agency feels would be of benefit to our particular business and industry in our State. No two States have the same problems, and our problems change all the time. We believe that this was recognized by Congress, and that it is intended that the States be given a wide latitude in conducting these programs. However, States are not given this latitude. We, again, feel that we at the State level and at the local level know what our particular problems are and that if we are doing our job we should be given this latitude to pick and choose the areas in which we should be working most closely. You can't hit and miss these problems, you can't cover them in general; they have to be specific.

For example, the Office of State Technical Services requires designated agencies to specify exactly what projects will be completed during the grant period to include specific titles of seminars, the audience to be reached, estimated amount of user fees to be collected, et cetera. It is often too difficult to foresee the need for a specific seminar a year in advance. Designated agencies are also required to price all projects to include individual line items such as personnel, their salaries and percentage of time to be spent on each project; and line-item cost of such things as travel, consumable supplies, communications, and so forth.

The fiscal year 1967 grant policies provided that the Office of State Technical Services would exercise line-item control of expenditures only for projects approved for a Federal share of $15,000 or over. They have revised grant policies for fiscal year 1968 so that control of line-item expenditures will be exercised for all line items approved at a total cost of $1,000 or more.

The Office of State Technical Services requires all wood-related proposals to be reviewed by State foresters and the Director of the Cooperative Extension Service for possible duplication and a statement from such official that the proposed project does not duplicate the readily available programs.

I think we all very strongly feel that duplication and overlapping of functions and programs is something we want to avoid. But, again, I say, our office has devised, and working directly through the Government, means to utilize the money that we have available, and we are certainly not going to have any overlapping.

They also require that all proposals relating to agriculture products be reviewed by the Director of the Cooperative Extension Service and the commissioner of the State department of agriculture for possible duplication. These requirements can be particularly onerous, since the Governor of the State is required to sign a certificate at the time the program is submitted that the program does not provide services which are readily available.

We do not want to proliferate these programs; we do not want to get into other areas of other departments of the State and other problem areas of the State, but we feel we know where these occur. If we don't, we should; and we feel we should have wider latitude in making this decision.

We believe, as mentioned before, that the State should have wide latitude within broad general guidelines. We feel that the Office of State Technical Services should not control line-item expenditures. We also feel that we should not have to spell out in detail each project we undertake. For example, we believe that during our field visitation program we will discover common problem areas in industry groups. Some of these problem areas could probably be handled by seminars, demonstration projects, or workshops. However, unless a demonstration project, workshop, or seminar is included in the approved program a State cannot conduct it unless they first get permission from the Director, Office of State Technical Services. This takes time, and it does not always work for the best advantage of the program, we feel. Decisions such as this should be left to the State.

We also feel that the certifications of the Governor and the head of the designated agency about whether there is duplication should be sufficient, and that the statements from State foresters, commissioners of agriculture, and so forth, should not be required. It is just more paperwork.

We believe that if sufficient money is not available to fund the Federal portion of a program for the amount requested by the State, the Office of State Technical Services should approve the program, provided it meets all other criteria for approval, and grant the money which is available and leave it to the State's discretion as to how they will distribute the money between projects.

All of my comments pertain to the State Technical Services Act of 1965, and what we are doing in West Virginia. I would, however, like to touch briefly on one or two other areas.

NASA has established seven regional dissemination centers. We believe in the purpose of this regionalism and the necessity of it. However, the information resources include computer access to a large body of scientific and technical information. We have reason to believe that these centers are competing for business, because we have been contacted by no less than four of them, explaining their services and soliciting our involvement. The very name "regional center" indicates that each of these has a specific geographical area of responsibility; however, this evidently is not true.

Senator RANDOLPH. I would like to comment at that point.

It seems to me that we are hearing again what we have heard before on this point, and that is as testified hitherto, I believe, gentlemen, by the witness, Mr. Gifford, who appeared for the Southern Interstate Nuclear Board.

Is this correct, that you had a discussion with him, or have you heard his views on this point?

Mr. ANGUS PEYTON. Yes. We have his testimony and I have talked to him about this whole situation. He is very much aware of it, and we are, too.

Senator RANDOLPH. It seems to be a field that is investigated by others than yourself, Mr. Peyton. So, we will have to go into this in our subcommittee a little more deeply—not this morning, but at a later date.

Thank you.

Mr. ANGUS PEYTON. I do not know whether you covered the cost of the services at the regional centers or not.

I might make one comment, that we feel that because we are at least partially supported by Federal funds, that designated agencies for this program should not have to pay the full subscription necessary for these services, particularly when half of the State technical services are off Federal funds.

In the conduct of our State technical service program, we have made use of the Clearinghouse for Scientific and Technical Information, the Library of Congress, NASA, and trade journals, the private abstract services, and the private business. There are so many agencies involved in technology transfer that it is hard to determine to whom one should go for solution of a problem.

We found that the National Referral Center for Science and Technology, the Library of Congress, has been one of our better sources for determining sources of information.

Another excellent source is the NASA Tech Brief. These briefs oftentimes contain much information which is of interest and value to the small businessman whom we are trying to approach.

Again, I can't emphasize too much that the real value of this program is to the small businessman. The larger corporations have their own staffs. We have got to get down to the small businessman who needs information. Sometimes he does not even realize he needs it; we have to tell him.

Much of the information contained in the Fast Announcement Service, published by the Clearinghouse, is academic and of little or no use in technology transfer. One of the problems we have in West Virginia, and I am sure this exists in other States, is that the businesses which need the most help are small- or medium-size businesses. These busineses need to be helped, and to catch up to the present state of the art.

I am personally familiar with some of these smaller businesses in West Virginia that could subcontract to many of our larger organizations and industries if they just had the help and the technical information about new machinery, how to really build the system's approach to marketing their product. Sometimes they feel, if they just have a new piece of equipment, they could solve their problem. This is not necessarily true. Their own operation needs to be looked at; it needs to be looked at by people who are expert. These businessmen cannot afford consultants or the scientific approaches that are necessary to really make them a viable part of the economy.

In many cases, the first task with smaller businesses is to upgrade management skills. The owner is often the operator of the business,

and it is he who is the decision maker. Unless this business is properly managed, no amount of effort will encourage the owner or manager to apply new technology to his operation. The Office of State Technical Services has ruled, arbitrarily we think, that management skills are not covered by the State Technical Services Act. Therefore, no programs can be initiated under the act to upgrade the skills.

Senator RANDOLPH. At that point, Mr. Peyton, you are critical—and you have reason to be, I am sure. We are told by the Department of Commerce, by the legal staff there, that the act does not cover the so-called business management area.

Do you have any recommendation for legislation in this situation?

Mr. ANGUS PEYTON. I believe that they may be correct in that. I feel that probably there should be an amendment to the act to allow it, because, from what I can tell, all of this information that is disseminated to our industry and our small business people, unless they can upgrade and understand new techniques and management skills, unless they themselves can be educated in the areas that are needed for management, I think, at least a lot of this program, a lot of the value of it, will be lost.

Specifically, you asked do I have any suggestions.

I certainly will have some suggestions for you on this.[2]

Senator RANDOLPH. The subcommittee will appreciate it.

It will be helpful.

Mr. ANGUS PEYTON. I think it is particularly necessary in our State, one of the smaller States, because we do not have the larger business schools. And this is our problem, an educational problem.

I certainly hope that my comments today will not be construed as condemning the State Technical Services Act of 1965, NASA regional dissemination centers or other technology transfer programs. In going over this testimony, I was quite concerned that people might feel that we are being overly critical. We are trying to be constructive in our criticism rather than destructive. I think we are learning new things everyday, and maybe we can come up with some constructive criticism. That is what we want to offer.

We feel that the State Technical Services Act has much to offer West Virginia, and it probably has more to offer our State than maybe some of the larger ones.

We feel that in order to develop our economic base, a program of this type is really one of the absolute necessities in the total overall attempt to develop technical skills and job opportunities in our State.

So, Senator, we are very much interested in this act and what it can do, and we would like to expand it. We would like to have more latitude in developing and working with it. Because we find that trying to live within some of the guidelines is very difficult.

What I have tried to convey here is that no two States have the same problems. Therefore, the solution of the problem is a must here.

I do believe that the large international firms with sophisticated development staffs are not firms that would benefit from our program. The small, medium-sized businesses which have little or no research ability and engineering capability, and whose owner or manager is involved on a full-time basis with meeting the payroll, that is the type of business and businessman that can benefit from these programs.

[2] Retained in committee files.

Because of this, I would recommend that the States be allowed to conduct their State technical services programs as the Governors of the States see fit, as long as they conform to the State Technical Services Act.

I also recommend that NASA regional centers operate on a regional basis, rather than compete for business in all States. I feel that these centers should strive to reduce subscription cost, so the small and medium-sized business can afford to subscribe. They should also develop techniques so that available information will be accessible to, and usable by, these businesses.

We have enjoyed excellent cooperation from the Office of State Technical Services and other Federal agencies involved in technology transfer. The big problem has been in knowing which agency to contact. I would hope that the consolidation or centralization of transfer agencies would receive consideration by this committee.

I would like to express my sincere appreciation for the opportunity to appear here before you today. And the information that you requested, we will attempt to supply as soon as we can.

Thank you very much.

Senator RANDOLPH. Thank you, Mr. Peyton.

(The prepared statement of Mr. Angus Peyton follows:)

STATEMENT OF ANGUS E. PEYTON, COMMISSIONER, DEPARTMENT OF COMMERCE, STATE OF WEST VIRGINIA

My name is Angus E. Peyton. I am appearing here as a representative of the State of West Virginia in my functional capacity as Commissioner of Commerce and head of the designated agency for our State Technical Services.

As I understand it, the purpose of this hearing is to aid in establishing future policies for Federal technology transfer. Therefore, I would like to first tell you what we are doing in West Virginia.

Before Public Law 89-182, the State Technical Services Act of 1965 was passed, we had established in the Department of Commerce, a Science and Technology Unit; one of the responsibilities of which was to encourage State business and industry to take advantage of new technology.

We were quite pleased when the State Technical Services Act was enacted into law. We knew that it was not a panacea; but we felt that it would enable West Virginia State Government to increase its efforts in assisting existing businesses and industries.

Shortly after passage of the State Technical Services Act, Governor Hulett C. Smith named the Department of Commerce as the designated agency to coordinate and administer programs under it.

The Department applied for a $25,000 planning grant which was received early 1966.

A Five Year Plan was prepared in accordance with provisions of the Act. This plan and an annual program for fiscal year 1967 was submitted to Office, State Technical Services, U.S. Department of Commerce in June 1966.

We felt that for a technical services program to be effective, it would have to be geared to the needs of state businesses and industries, particularly small and medium size firms which had not kept pace with the state of the art and could not afford research and development staffs. We considered several approaches and after much study and consultation with businessmen and educators, decided to place emphasis on a person-to-person approach. By so doing, we could isolate problem areas and determine needs of business and industry.

The Fiscal Year 1967 Technical Services Program was not approved and funded by the Federal government until December 1966. Therefore, this program did not get under way until calendar year 1967.

Participants in the program are West Virginia Department of Commerce, both as designated agency and qualified institution; West Virginia University, Morgantown, West Virginia; Concord College, Athens, West Virginia; Technical

Consultants, Inc., Huntington, West Virginia, a non-profit development corporation; and Bethany and Shepherd Colleges, Bethany and Shepherdstown, West Virginia, respectively. The Department of Commerce, West Virginia University, Technical Consultants, Inc., and Concord College are each assigned specific geographical areas of responsibility within the State. Bethany and Shepherd Colleges are to participate by conducting seminars.

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Chambers of Commerce and educational institutions in the areas where the conferences were held, cooperated to the fullest extent in planning, coordinating, promoting and conducting them.

Two hundred twenty five persons, representing 138 companies, attended the conferences; and it is felt that they did much to acquaint business and industry leaders with the purposes of the program and the services available to them.

Field Visitation Projects were included for West Virginia Department of Commerce, West Virginia University, Concord College and Technical Consultants, Inc. Participants involved in these projects have visited approximately 200 State firms. These visits have served to acquaint owners and managers of business and industry with the technical services program; and have made them aware of sources and utility of new technical information concerning products, processes, services, equipment and procedures; and have identified areas of interest and common problems.

Initial field visits were made to a cross-section of West Virginia business and industry; however, beginning July 1, 1967, field visits have been concentrated on one industry grouping at a time. This aids in identifying common problem areas and enhances the capability of the designated agency and participants in problem solving and transfer of technology. The first industry to be concentrated on was major SIC Group 35, Machinery, Non-Electrical.

The program has been operating such a short time that it is not possible to determine direct benefts resulting from this project. However, it is out considered opinion that firms visited have a better understanding of the program and that this will bear justifiable results later. It has also resulted in identification of areas of interest to be used in selecting information dissemination.

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The Department of Commerce also publishes and distributes to about 3,500 addressees, a quarterly Technical Services Newsletter.

The Information Dissemination Project will expand and become more meaningful as additional firms are contacted through the field visitation program and as companies' interests are determined. As mentioned earlier, concentrating field visit activities on major industry groups will aid in identifying common problem areas and enhance the capability of participants to disseminate needed technical information.

A Technical Reference Service project was included in the program. This service was to assist local industries in locating sources of scientific and technical

expertise and technical information. It was to be provided by West Virginia Department of Commerce on a statewide basis and West Virginia University was to assist in identifying sources of expertise and in developing the service.

To date, quite a few directories, rosters and other reference materials have been obtained; and sources of much scientific, professional, engineering and technical expertise, testing laboratories, research facilities, consulting firms and technical assistance groups, have been identified.

Questionnaires have been distributed to Consultants, Professors who engage in consulting work. Patent Attorneys, CPA's, etc. Infromation obtained through these questionnaires will be used in preparation of technical reference directories.

Several inquiries for sources of information have been received; all of which have been satisfied.

A seminar project entitled "Technical Operating Problems of Small Business Firms" was included in the program and has been completed. It was conducted by Bethany College and consisted of six seminars on Current Management Problems and Future Trends; Current Cost Problems of Small Business Firms; Introduction and Use of Data Processing in Small Business; Planning for Future Technical Changes; Quantitative Methods in Management Science; and Special Case Studies by Participants.

The project was conducted by staff and faculty members of Bethany College and guest speakers. Invitations were extended to about 400 business firms in the Northern Panhandle of West Virginia and press and radio coverage were excellent. Invitations were extended by mail and on several occasions Bethany College telephoned 20 to 30 firms selected at random from their mailing list to extend a personal invitation. However, despite excellent promotion and publicity and a registration fee of only $10, business and industrial firms did not respond as had been extected. Only six persons, representing four firms, attended.

Several factors appear to have influenced the attendance at these seminars. For example, a conflict with adult education programs in the area, which were scheduled after seminar schedule was published; disinterest on the part of individuals and firms and inability to see the importance of the program; and the press of business, particularly among small business firms.

On a purely quantitative basis this project was a failure, however, participants showed enthusiasm for the presentations. Each seminar was scheduled for one hour, open for discussion at any point; but question periods extended the weekly programs to a length of two to two and one half hours.

The fiscal year 1967 program also includes a Business Management Institute to be conducted by Shepherd College. It consists of six seminars dealing with the use of modern management technology in business, commerce and industry. Subjects include Use of Data Processing in Modern Business; Application of PERT and CPM in Decision Making and Business Operations; Marketing Technology; Modern Financial and Accounting Concepts; Cost Reduction and Profit Improvement; and Use of Technical Information in Modern Business.

This project was planned for late Spring 1967; however, for various reasons it has not been conducted to date. It will be conducted in early Spring 1968.

I have described briefly the West Virginia Technical Services Program and the way we have approached technology transfer. I might add that the fiscal year 1968 program which has been submitted to Office, State Technical Services is a continuation of the fiscal year 1967 program. The main difference being that seminars conducted by Bethany and Shepherd Colleges will not be repeated; but two symposia, one on glass technology and one on the use of radioisotopes in industry and medicine are included. These symposia will be conducted by Wheeling College.

The cost of the fiscal year 1967 program as submitted to Office, State Technical Services was $175,950; $87,975 of which was to be provided from non-federal funds and a like amount of federal matching funds were requested. The program was approved in total; however, only $64,690 in federal matching funds were provided. A like reduction in non-federal funds reduced the amount available for the program to $129,380.

The cost of the fiscal year 1968 program as submitted to Office, State Technical Services is $181,763 and we requested $90,881 federal matching funds. Office, State Technical Services has advised us that only $60,000 in federal funds will be available, reducing the total program to $120,000 for fiscal year 1968. At the time we were informed of this, we were also asked by the Director, Office, State Technical Services, to advise him how we would distribute these funds between projects.

Regarding funding of State Technical Services Program, we believe the formula Office, State Technical Services uses in allocating funds discriminates against small states with low technological bases such as West Virginia. We recommend that they devise a formula which takes into consideration all factors outlined in the State Technical Services Act, instead of considering population only, as they are now doing. Secondly, administrative costs do not rise in direct proportion to operating costs. Conversely they are not reduced in direct proportion to a reduction in operating funds. Therefore, an effect of austere funding is to increase the ratio of administrative costs to operating costs.

We know there are many different ways of transferring technology. It can be on a person-to-person basis as we are doing. It can also be done by conducting seminars about technical subjects which the designated agency feels would be of benefit to business and industry in the State. No two states have the same problems, and problems change. We believe that this was recognized by Congress and that it was intended that states be given widest latitude in conducting programs. However, states are not given this latitude.

For example, Office, State Technical Services requires designated agencies to specify exactly what projects will be conducted during the grant period to include specific titles of seminars; the audience to be reached; estimated amount of user fees to be collected, etc. It is often difficult to foresee the need for a specific seminar a year in advance. Designated agencies are also required to price all projects to include individual line items such as personnel, their salaries and percentage of time to be spent on each project; line item cost of such things as travel, consumable supplies, communications, printing; etc.

The fiscal year 1967 grant policies provided that Office, State Technical Services would exercise line item control of expenditures only for projects approved for a federal share of $15,000 or over. They have revised grant policies for fiscal year 1968 so that control of line item expenditures will be exercised for *ALL LINE ITEMS* approved at a total cost of $1,000 or more.

Office, State Technical Services requires all wood-related proposals to be reviewed by State Foresters and the Director of the Cooperative Extension Service for possible duplication and a statement from such officials that the proposed project does not duplicate readily available programs. They also require all proposals relating to agricultural products to be reviewed by Director of The Cooperative Extension Service and the Commissioner of the State Department of Agriculture for possible duplication. These requirements can be particularly onerous, since the Governor of the State is required to sign a certificate at the time a program is submitted that the program does not provide services which are readily available.

We believe, as mentioned before, that the State should have wide latitude within broad general guidelines. We feel that Office, State Technical Services should not control line item expenditures. We also feel we should not have to spell out in detail each project we undertake. For example, we believe that during our field visitation program we will discover common problem areas in industry groups. Some of these problem areas could probably be handled by seminars, demonstration projects, or workshops. However, unless a demonstration project, workshop, or seminar is included in the approved program, a state cannot conduct it unless they first get permission from the Director, Office, State Technical Services. Decisions such as this should be left to the States. We also feel that the certifications of the Governor and the head of the designated agency about whether there is duplication should suffice; and statements from State Foresters, Commissioners of Agriculture, etc., should not be required.

We believe that if sufficient money is not available to fund the federal portion of a program for the amount requested by the State, Office, State Technical Services should approve the program, providing it meets all other criteria for approval; grant the money which is available and leave it to the State's discretion as to how they will distribute the money between projects.

All of my comments have pertained to the State Technical Services Act of 1965 and what we are doing in West Virginia. I would like to touch briefly on one or two other areas.

NASA has established seven Regional Dissemination Centers; the information resources of which include computer access to a large body of scientific and technical information. We have reason to believe that these centers are competing for business because we have been contacted by no less than four of them, explaining their services and soliciting our involvement. The very name "Re-

gional Centers" indicates that each of these has a specific geographical area of responsibility; however, this evidently is not true.

We have talked with personnel from some of the centers to determine whether their services would be valuable in the information dissemination portion of the State Technical Services Program. We have found that a problem must be so narrowly defined that the answer is almost evident when it is defined. This has been borne out by the research and development activity of a large steel corporation in West Virginia. This activity subscribed to the services of one of the regional centers at one time and dropped their subscription because it was of little benefit to them. They found they could get the same information at less cost by conventional means.

We have been amazed at the cost of the services of the regional centers. We feel that because they are at least partially supported by federal funds, that designated agencies for the State Technical Services Program should not have to pay full subscription fees for their services. Particularly when half the State Technical Services funds are federal funds.

In the conduct of our State Technical Services Program we have made use of the Clearinghouse for Scientific and Technical Information, Library of Congress; NASA; AEC; professional and trade journals; private abstracting services; and private business. There are so many agencies involved in technology transfer that it is hard to determine to whom one should go for solution to a problem. We have found that the National Referral Center for Science and Technology, Library of Congress has been one of our better sources for determining sources of information. Another excellent source is the NASA Tech Brief. The briefs oftentimes contain much information which is of interest and value to the small businessman.

Much of the information contained in Fast Announcement Service, published by the Clearinghouse, is academic and of little or no use in technology transfer.

One of the problems we have in West Virginia and I am sure this exists in other states is that the businesses which need the most help are small and medium size businesses. With many of these businesses it is a case of helping them "catch up" to the present state of the art. Businesses such as these must be dealt with on a "down to earth basis" and much of the information published by the Clearinghouse in the Fast Announcement Service and the information available from Regional Dissemination Centers is practically useless.

In many cases the first task with smaller businesses is to up-grade management skills. The owner is often the operator of the business and it is he who is the decision maker. Unless business is properly managed, no amount of effort will encourage the owner or manager to apply new technology to his operation. Office, State Technical Services has ruled, arbitrarily we think, that management skills are not covered by the State Technical Services Act. Therefore, no programs can be initiated under the act to up-grade these skills.

I hope my comments today will not be construed as condemning the State Technical Services Act of 1965, NASA Regional Dissemination Centers or other technology transfer programs. I would hope that they would be considered constructive criticism rather than condemnation.

Most of my comments have pertained to the State Technical Services Act, because that is the program we are most familiar with.

We feel the State Technical Services Act has much to offer West Virginia, as well as other states. What I have tried to convey is, that no two states have the same problems; therefore, solutions to problems vary. I do believe large national and international firms with sophisticated research and development staffs are not the firms which will benefit most from federal technology transfer programs. The small and medium sized business, which has little or no research, development and engineering capability and whose owner or manager is involved on a full time basis with "meeting the payroll" is the type business which can benefit from these programs. Because of this, I would recommend that the states be allowed to conduct their State Technical Services programs as the governors of the States see fit; as long as they conform to the State Technical Services Act.

I would also recommend that NASA Regional Centers operate on a regional basis, rather than compete for business in all states. I feel these centers should strive to reduce subscription costs so that small and medium size business can afford to subscribe. They should also develop techniques so that available information would be accessible to and usable by these businesses.

We have enjoyed excellent cooperation from Office, State Technical Services and other Federal agencies involved in technology transfer. The big problem has been in knowing which agency to contact. I would hope that consolidation or centralization of transfer agencies would receive consideration by this committee.

I would like to express my sincere appreciation for the opportunity to appear here today to express the views of one of the smaller states, which we know, has much to gain from Federal-State cooperation in technology transfer.

Senator RANDOLPH. I am familiar, perhaps in greater degree, with the use of the tools under the Technical Services Act in the State of West Virginia than in other States. I do know that we are finding our way, by trial and error to a certain degree. But I can agree with Mr. Peyton wholeheartedly on the fact that it is basically a sound program, and if there are problems that certain States have in adjusting the act to the purposes of their particular States, that is understandable, and it will necessarily have to be done.

I think, however, that Mr. Peyton is correct in saying that we must continually set our sights beyond the boundaries of a community or a county or even a State, because, I would add, over the mobility of our people, the fact that we are on the move. This is not just a person moving between office and home or factory or residence, this is a mobility that has taken hold of our economic life, and for that reason we are in closer proximity in thought as well as in so-called distance.

So, to a degree, we and the participants are brought together, and I think this is a challenge sometimes to us. We are reluctant to move in concert with other areas that have much in common with us, and I hope that the hearings have developed, at least in part, that type of information that I believe to be of a positive nature.

Dr. Hedden, you may present your testimony now.

Would you highlight your statement?

And, of course, your statement will be included in full in the record.

Dr. HEDDEN. Thank you, Senator.

In the interest of time, I will skip very rapidly to getting into some of the recommendations and conclusions, rather than read the entire statement.

I believe most of my remarks are directed to the use by the smaller companies in our State, because I feel that this is what is most needed.

After looking at the enormous amount of information to be transferred in our Extension operation—I looked at some of the distribution of companies as to size and found that most of our engineering programs were serving really only the larger companies. But, in fact, in Wisconsin these represent only about 2 percent of the corporations, because 45 percent of all of the companies that manufacture have seven or fewer employees. And we have found many other instances which I think indicate that the smaller company management does not avail itself of the opportunities.

So, I think that we can say that we have tried to examine the reasons for this, and that we have come to some conclusions. These are some of the things we feel are the reasons behind the lack of the smaller company availing itself of the information:

1. The concern or preoccupation by the small company manager with current pressing problems of finance, production, and sales to the exclusion of technological planning.

2. The lack of formal knowledge of the influence of technological factors on business in general.

3. The lack of awareness of available knowledge or sources of knowledge.

4. The lack of trained personnel to interpret and apply the available knowledge.

5. The lack of adequate financial resources to put the knowledge to work.

Several studies indicate that companies outside of the aerospace industries have made relatively little use of the federally financed research literature. This gap widens even more as we compare companies in the smaller size range. There are exceptions, of course, in the small technologically based company, though only a relatively small number of these exist in Wisconsin.

Though much solid base of long standing existed in Wisconsin in the Extension Service to industry, the State Technical Services Act was looked upon as an important new dimension to complement and extend existing programs both by enlarging the scope and increasing the number of types of service not economically feasible in the past.

Two features of the State Technical Services Act show promise. These are the emphasis on the State's participation where determining needs and program content were delegated to the States and the emphasis on using existing State institutions as the working base.

Senator RANDOLPH. Dr. Hedden, as I look at your testimony I note here that you say that, in your State as a whole, 98 percent are small businesses with less than 500 employees.

Dr. HEDDEN. Yes.

Senator RANDOLPH. And 45 percent of all manufacturing firms have seven or fewer employees.

Now, just at that point I would like to have a comment from other States.

How do you run percentagewise on this situation?

Mr. LARSON. The best figure that I have is that there are approximately 45,000 manufacturing entities, firms, in New York State, and approximately half of these have less than 10 employees. However, in New York State we have a diversification of industry, such that in each of 10 of the major industry categories there are more than 70,000 employees working.

Mr. ALLEN PEYTON. In West Virginia, Senator, in manufacturing and construction together, which we have lumped together, there are 74-odd percent with nine or under employees.

Senator RANDOLPH. It is somewhat comparable, then; though there are variations.

Thank you. I thought we should have that.

You may go ahead.

Dr. HEDDEN. Also it might be well to bring out that in spite of the fact that there is a large number of corporate entities in the smaller range, about half of our employees engaged in manufacturing are in this intermediate range of the several hundred employees. And this is a big group that we are most concerned with.

The Wisconsin State technical services program is designed in accordance with the provisions of the act to fill needs not served by other existing methods. The principal effort was planned in information and referral services, field services, and new technology briefings for industrial management. Less emphasis was placed on traditional

short courses, workshops, and so on because these already existed, and were capable of a high level of support.

The information and referral services, which had begun in limited fashion in 1965, were expanded in scope and personnel under STS funding. From an early use rate of six to 10 requests per month, the use rate reached about 380 per month in August 1967, indicating a very dramatic increase. This sort of activity gives the smaller firm access to this very large body of information where it, itself, is not able to identify it from its own resources.

The agricultural programs in Wisconsin and in other States provided much data on the adoption process. As a result, the project was devoted to the development of "awareness" in smaller company managers concerning items of "new technology" of probable interest to the principal industries. Because of the objective of reaching top management of the small company, a regional, one-half day conference format was selected to improve the chances of attracting this audience.

The first series was considered a success when the audience, essentially all presidents or other top corporate officers, was composed of 70 percent "small business" executives. A followup evaluation interview 2 months later disclosed that two-thirds of the companies had utilized or investigated further at least one item from the seven short presentations. Though this effort represented only 5 to 10 percent of the STS budget, we believe it shows promise of being an effective transfer method for the smaller firm. If transfer indeed did occur, this calculates out to be about $30 out-of-pocket cost per transfer.

Briefly, without going into detail, we tried an experiment on the special merit program under the STS by having a mobile van which goes to companies around the State on request and attempts to teach machinability of metals, an item that is very important in Wisconsin in the smaller companies. This also seems to show a great deal of promise, although we have some reservation about the details at this time. So, we are taking the university out into the smaller communities, rather than have them come to us.

We have put some effort into the field operations, but because of budget limitations as of this time we are unable to do an extensive job here.

We were looking forward during this next year to using our existing county and field staff people of the university as personnal contacts in the field, and we feel that these will do a great deal of personal interpretation. Here, again, the funds are not available to do this, but the existing people have indicated willingness to be a part of our program.

There are problems, at least problems of the small technologically based firm, that are pertinent here. This type of firm does locate and use the information it needs. The major differences are in the technological orientation of the entrepreneur and/or top management, and the presence of built-in expertise for utilizing knowledge. Often neither of these factors is present to sufficient degree in the average smaller firm. Technology transfer and application are still usually accomplished in the final analysis by the personal action of individuals, though channels for awareness and details are necessary. This suggests education—continuing education—or the manager is important.

I still believe that the technical professional literature is the best storage facility for knowledge. But it is of little use to the untrained. Even the specialist in one field is handicapped in neighboring fields. This suggests that the field man, the "industrial" county or area agent, has a very important role. Much practical knowledge exists in the available R. & D. effort. Identification by highly trained generalists with industrial experience and distribution according to selective dissemination of information principles will help a great deal. NASA Tech Briefs, for example, seem to be highly regarded by the people that I have talked to that have made use of this resource. This seems to incorporate practical knowledge of the existing literature.

I would like to summarize very briefly these recommendations. We have looked here at the problem of technology transfer from the user end. What actions or legislation can we recommend that might help?

1. The OSTS format seems to offer excellent promise in general. Improved longer range programs are likely if stability of funding and funding above some "critical mass" level can be obtained. Currently, the smaller States, on the formula basis, have so few dollars that expectations for major economic impact is unrealistic, although I hasten to add here that I do not think this is a serious problem in Wisconsin. We have adequate funds, here, but I have seen this handicap the other States.

2. Line-item approach in projects has limitations in flexibility. A project proposed by one institution in Wisconsin nearly 2 years ago is just being implemented. Two years is a long time in the current technological race. More flexibility, more trust in a "qualified institution" to serve the needs of its region would reduce this lag.

3. The current interpretation of the State Technical Services Act which tends to limit the act to "hard science and engineering" should be modified to broaden the scope. Much potential utilization of technology is still managerially limited. The management sciences, properly applied, should help the smaller firm prepare to enter the technological race. We need more education in the use of technology.

4. The limitation on individual consultation perhaps should be a bit more flexible where adequate private facilities are not available or very small firms are unable to afford them. Liberalizing this provision is a difficult problem and should be treated with great care. But more attention to the human interpreter in the information loop is needed to help the smaller firm.

5. Good "demonstration" techniques, long sought in the OSTS program, have been slow in developing. More emphasis should be placed on this point at the local level. Specifically, some elements of the demonstration or experimental station approach should be considered. The small businessman who can visit a facility and see the hardware and the processes in action can visualize applications in his company better than he can from the printed word. The excellent national centers such as Argonne Laboratory are fine, but for many companies they are too "far out" in technology and too far away in distance to be utilized effectively. Some of the technology needed is not of high order, nor is it necessarily very new. And, if our total economy is to be served, we must provide help in these areas, too.

Mr. Senator, I think this ends my formal remarks.

Thank you very much for the opportunity.

Senator RANDOLPH. Thank you, Dr. Hedden.
(The prepared statement of Dr. Hedden follows:)

STATEMENT OF DR. GREGORY D. HEDDEN, DIRECTOR, STATE TECHNICAL SERVICES PROGRAM, THE UNIVERSITY OF WISCONSIN

My name is Gregory Hedden. I am Director of the State Technical Services Department which is in the Division of Economic and Environmental Development, University Extension, University of Wisconsin. Our program is funded in part by a matching grant under the Office of State Technical Services, U.S. Department of Commerce. The University of Wisconsin was assigned the responsibility for the administration of the program by Governor Warren Knowles in the late Fall of 1965.

My statement discusses some of the problems of technology transfer to the smaller company, some of the experience in Wisconsin and some suggestions which may help serve the needs of the smaller firms.

As we address ourselves to the problem of better serving the smaller company, we can start with the assumption that changing technologies have an impact on all business and that corporate technological planning in some dimension must take place even in the smaller firm. The responsibility rests with the chief executive. If the smaller firm is not now using the available resources, then we should look to the chief executive at the user end of the channel for part of the answer.

Our observations indicate that he is often unaware of the implications and problems associated with technological change. Even if he is generally aware of the problem, he may not be adequately trained to deal with it. At the local level, continuing education, field services, and information services give us part of the answer.

One of the most pertinent operations for our present consideration is the University of Wisconsin Extension. The merging of the Agricultural and General Extension operations in 1965–1966 represented a major effort to combine under a single chancellor nearly all of the outreach arm of the University to effect a total service to the state and the region in continuing education. The history of General Extension in Wisconsin dates back to 1907 when the Wisconsin Legislature first appropriated funds for this unit. Today, the combined operation has a $16 million annual budget. All of this budget represents information transfer in some fashion.

Among the non-agricultural departments, the Departments of Engineering and Commerce are the largest. These served 22,000 people in the 1966–1967 academic year. The University Extension Department of Engineering conducted 260 courses in that year. The subjects ranged from traditional engineering refresher courses to advanced state-of-the-art courses such as computer applications in machine design. Two-thirds of the audiences attending multiple-day programs in Madison represent firms from out of state, while audiences in evening classes in Milwaukee are almost entirely local.

The companies represented by the attendance at these programs show a size distribution different from the distribution of the State's industry. In the State as a whole, 98% are "small businesses" with less than 500 employees, while 45% of all the firms that do manufacturing have seven or fewer employees. The distribution of company sizes represented in the multiple-day enrollments in Madison (by sample) indicates a skewing toward the larger, more technically sophisticated firm. This is true, generally, for both business management and engineering programs.

The distribution of company sizes served by the topics of principal interest to the smaller firm is shifted toward the median of about 150 to 200 employees with signficant attendance from firms in the very small size for evening classes.

The attendance pattern is not unexpected. Companies in the very small size categories will not send their people much over 20 miles nor will they attend three to four day programs. The small firm manager or employee is more likely to come to three on-day programs spread over three weeks than one three-day program. The smallest firms are more likely to come to a program consisting of several evening classes than the same program concentrated in a single all-day schedule.

The accumulated experience shows many of the difficulties in reaching the people in the smaller firm, especially the top management. The difficulties are even greater when the subject matter involves the traditional physical science and engineering topics. Several factors seem to contribute to this characteristic of the smaller firm:

1. The concern or preoccupation by the small company manager with current pressing problems of finance, production and sales to the exclusion of technological planning.
2. The lack of formal knowledge of the influence of technological factors on business in general.
3. The lack of awareness of available knowledge or sources of knowledge.
4. The lack of trained personnel to interpret and apply the available knowledge.
5. The lack of adequate financial resources to put the knowledge to work.

Several studies indicate that companies outside of the aerospace industries have made relatively little use of the Federally financed research literature. This gap widens even more as we compare companies in the smaller size range. There are exceptions, of course, in the small technologically based company though only a relatively small number of these exist in Wisconsin.

Though much solid base of long standing existed in Wisconsin in the Extension Service to industry, the State Technical Service Act was looked upon as an important new dimension to complement and extend existing programs both by enlarging the scope and increasing the number of types of service not economically feasible in the past. State policy required that the traditional business and engineering programs be essentially self supporting from fee income of the enrollments. This placed lower limits on audience size and limited the subject matter which could be served.

Two features of the State Technical Services Act seemed to show promise. These are the emphasis on the *State's* participation where determining needs and program content were delegated to the States and the emphasis on using existing State institutions as the working base.

The Wisconsin State Technical Services program was designed in accordance with the provisions of the Act to fill needs not served adequately by existing methods. The principal effort was planned in (1) information and referral services, (2) field services, and (3) new technology briefings for industrial management. Less emphasis was placed on traditional short courses, workshops and so on because these already existed, and were capable of a high level of support.

The information and referral services, which had begun in limited fashion in 1965, were expanded in scope and personnel under STS funding. From an early use rate of 6 to 10 requests per month, the use rate reached about 380 per month in August 1967. The requests represented a spectrum from copies of single citations or loan of reference works to development of bibliographies or state-of-the-art statements or referral. Referrals were made to sources of expertise in Wisconsin faculty, private industry or sources in other states or in Federal agencies. Of the 25 heaviest users, about one-third are "small business."

The agricultural programs in Wisconsin and in other states provided much data on the adoption process. The first step is generally conceded to be the "awareness" stage. As a result, a project was devoted to development of "awareness" in smaller company managers concerning items of "new technology" of probable interest to the principal industries. Because of the objective of reaching top management of the small company, a regional, one-half day conference format was selected to improve the chances of attracting this audience. The subject matter reflected the fact that Wisconsin is a quite typical manufacturing state.

The first series was considered a success when the audience, essentially all presidents or other top corporate officers, was composed of 70% "small business" executives. A follow-up evaluation interview two months later disclosed that two-thirds of the companies had utilized or investigated further at least one item from the seven short presentations. Though this effort represented only 5 to 10% of the STS budget, we believe it shows promise of being an effective transfer method for the smaller firm. If transfer indeed did occur, this calculates out to be about $30 of out of pocket cost per transfer.

A special merit project under STS has achieved considerable attention. A "mobile machineability laboratory," consisting of a van and trailer, has been traveling on request around the state and into neighboring states. The unit is equipped and instrumented to demonstrate some 10 to 20 concepts concerning the theory and practice of machineability of standard metals and alloys. Closed circuit TV closeups and motion pictures as well as live discussions show fine points of technique and optimization to the audiences within their own company premises. An expansion of this operation could bring to the small company, remote

from the industrial and educational centers, the benefits of current research and knowledge in other fields as well. The overall cost per person, including the set up, equipment and road operating costs are not significantly higher than a demonstration in a fixed location when one considers the number of people served per company per visit. A number of firms have requested repeat visits. Most companies requesting the visits are larger firms.

Since we postulate that the chief executive of the smaller firm is potentially the principal barrier to adoption of a new practice, communication with him is considered a most important step. A second effort which is believed to be important is the "field man" who by personal contact can inform the company manager of the available resources. One office has been opened in Milwaukee, but limited budgets have precluded extensive efforts to date. Efforts are now under way to utilize the existing county staff personnel and county offices as focal points for contact and "selling" the services.

Though progress is being made as evidenced by specific instances of utilization, much more needs to be done. Because of the considerable variety of needs, capabilities, technical competence and other factors, it would be unwise to attempt to characterize the smaller companies by a simple profile which can be used as a guide to a working relationship. In fact, a single transfer method would not serve all. Several techniques or channels commonly used by larger firms simply will not work well. Typical R & D budgets may run 3% of sales. Some larger firms use 2% of the R & D budget for information services. If the company is small, 2% of the 3% may well be far below a critical mass for effective operations.

Although there are problems, the example of the small technologically based firm is pertinent. This type of firm locates and uses the information it needs. The major differences are in the technological orientation of the entrepreneur and/or top management and the presence of built-in expertise for utilizing knowledge. Often neither of these factors is present to sufficient degree in the average smaller firm. Technology transfer and application are still usually accomplished, in the final analysis, by the personal action of individuals, though channels for awareness and details are necessary. This suggests education, continuing education, of the manager is important.

The professional technical literature, I think, is the best storage facility for knowledge. But it is of little use to the untrained. Even the specialist in one field is handicapped in neighboring fields. This suggests that the field man, the "industrial" county or area agent, has a very important role. Much practical knowledge exists in the available R & D effort. Identification (by highly trained generalists with industrial experience) and distribution according to Selective Dissemination of Information (SDI) principles will help a great deal. NASA Tech briefs seem to be viewed highly by the few that I have talked to that have made use of this resource.

In summary, we have looked at some of the problems of technology transfer from the user end. What actions or legislation can we recommend that might help?

1. The OSTS format seems to offer excellent promise in general. Improved longer range programs are likely if stability of funding and funding above some "critical mass" level can be obtained. Currently, the smaller states, on the formula basis, have so few dollars that expectations for major economic impact is unrealistic.

2. The line item approach in projects has limitations in flexibility. A project proposed by one institution in Wisconsin nearly two years ago is just being implemented. Two years is a long time in the current technological race. More flexibility, more trust in a "qualified institution" to serve the needs of its region would reduce this lag

3. The current interpretation of the State Technical Services Act which tends to limit the projects to "hard science and engineering" suggests that the act be modified to broaden the scope. Much potential utilization of technology is still managerially limited. The management sciences, properly applied, should help the smaller firm prepare to enter the technological race. We need more education in the use of technology.

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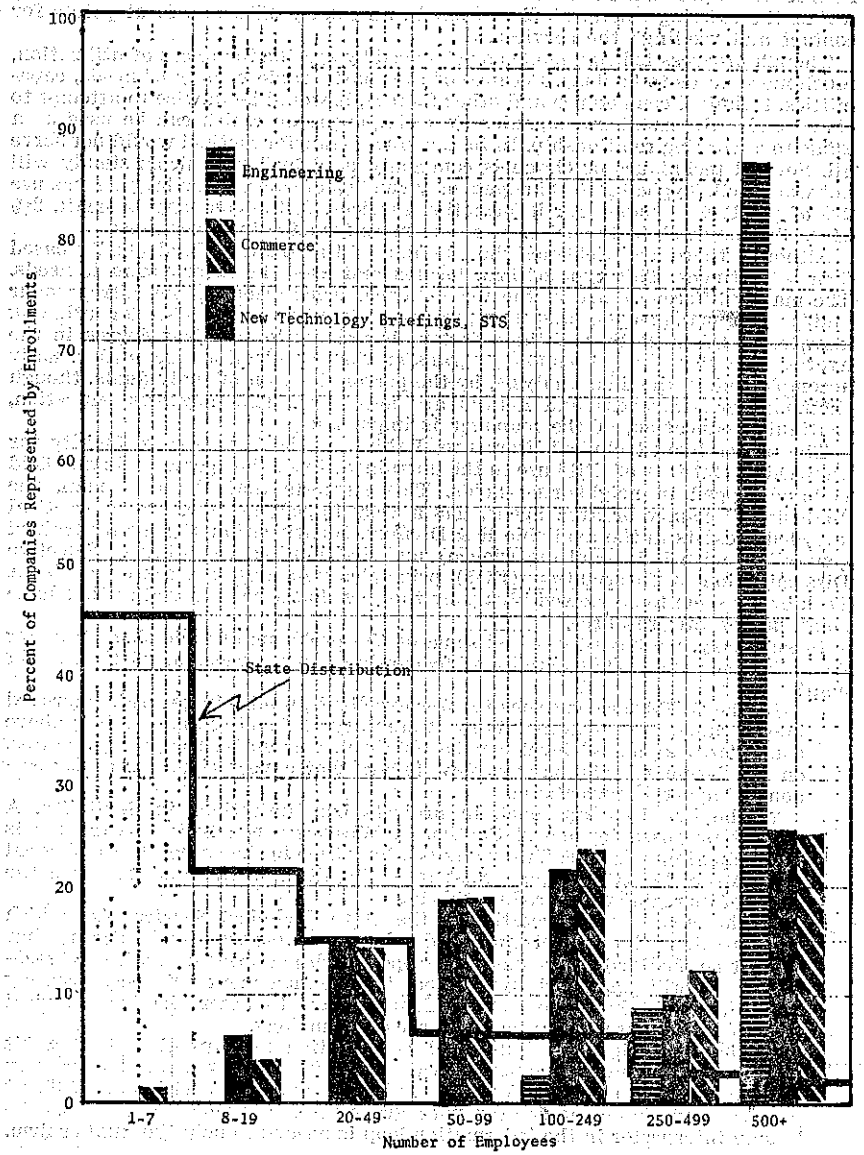

Senator RANDOLPH. I turn to one point you made, on pages 6 and 7, where you speak of the problem of personnel.

We have had other witnesses who focused attention on the need for manpower, and I have some question as to whether certain people can be used effectively in this work. I am inclined to believe that maybe we cannot use some person that you think we can use. I have a feeling that we need perhaps specialists beyond the ones that can't be trained, so-called, on the job. I want to take issue with you. But I think this is an area which the subcommittee will want to explore, and your testimony will be helpful to us as well as the testimony that has been received.

Off the record.

(Discussion off the record.)

Senator RANDOLPH. I want to express my appreciation to Richard Carpenter, Blake O'Connor, and Dan Coughlin, who have been very helpful in arranging for witnesses and have done much work in the background, for which I, as chairman of the subcommittee, am most appreciative.

So, Mr. Larson, would you give your testimony?

And the able gentlemen of the staff will question you if it is felt desirable.

Will you identify yourself, Mr. Larson, and present your statement?

Mr. LARSON. Thank you, Senator Randolph.

My name is Robert Larson. I am director of the New York State technical services program.

The New York State Department of Commerce was named by Governor Rockefeller in 1965 as the designated agency in the State for the planning and administration of the State technical services program.

The department has long had programs intended to aid commerce and industry in the State, including programs for the improvement of management and marketing. The State also has had an advisory council for the advancement of industrial research and development, which was instrumental in the development of an early program for State technical services in New York.

We prepared and submitted a 5-year plan and annual program in the spring of 1966. A grant of approximately $200,000 was made by the Office of State Technical Services in Washington in 1966.

In the meantime, the New York State Legislature had voted $500,000 for matching purposes from New York for the fiscal year 1966–67, which happens to start on April 1 instead of July 1.

In the summer and fall of 1966 an annual program for fiscal year 1967 and a revised 5-year plan was prepared and submitted to the Office of State Technical Services. A grant of approximately $300,000 in Federal funds was received from fiscal year 1967 Federal funds.

As the result of these appropriations, some 20 highly qualified institutions in New York State are now involved in 100 or more projects for the improved use of science and technology.

Early in the planning, it was apparent that it would not be feasible to determine immediately the need of industry and commerce in the State for a technical services program in a way which would be useful for detailed planning of projects.

As I said earlier, in the manufacturing industry alone there are approximately 45,000 companies of which about one-half employ less than 10 people. But more than 70,000 people work in each of 10 major industry categories—classifications—in New York State.

For this reason, because of the highly diversified industry in the State, it appears essential to involve as many of the highly qualified technical educational institutions and other technical institutions as possible.

The projects which have been founded in New York State are described in the brochure which is available.

A third annual program has been prepared and submitted for fiscal year 1968 funding. It has been approved in principle with the limited funding available to the Office of State Technical Services at this time.

These funds will allow us to continue projects at most of the institutions which have been involved in the program, but will not provide funds for the extension of the program to a number of capable community colleges and 2-year institutions within the State.

Earlier in the New York State fiscal year 1967–68, the New York State Legislature provided an additional $500,000 for matching programs. This was the second appropriation.

It does not appear to be advisable to fund any project at a level below a critical size at most institutions. Unless the project at an institution requires a considerable involvement in the commitment of resources, the chances of success are relatively poor.

Questions have been raised with regard to information sources. In New York State we are especially well equipped with library-type resources. All of the library institutions have excellent library facilities and, in general, their librarians are quite knowledgeable in the acquisition of technical information.

The larger business institutions in the State have long been expert in this acquisition and use of scientific and technical literature to meet their needs. In relatively rare cases do the smaller companies use the technical literature in the solution of their problems.

In those cases where there appears to be a need or an opportunity for them to use Government technical reports, they will usually need help in the interpretation of the information and in the use of this information to solve their problems.

Many of these problems are local in nature and peculiar to the specific process or product involved.

However, in some cases, it is true that aggressive companies, some of them small, will find valuable bits of information which can be made available through DOD, NASA, or other channels. These usually need to be interpreted by the State technical services agent or by some other service of this kind.

Many companies, both large and small, rely heavily on their vendors for technical information. Greater technical sophistication can make them less dependent on vendor sources of information.

Most of the useful transfers of information to smaller companies will occur on a face-to-face basis between the user and the transfer agent. Fieldwork and workshops are among the promising projects in New York State. Referral services can also be very useful.

I believe that the dissemination of documents will help the more sophisticated companies and may arouse the interest of others in the program.

The question of regional programs has been widely discussed. Experience seems to show that the involvement of several States requires so much effort in planning and funding that such regional programs do not become effective within a reasonable timespan. Informal cooperation and free interchange of plans and project information appears to be the more promising solution at this time, at least for New York State.

The problem of getting feedback from project evaluation is difficult to solve. Fees collected, services used, transfers made, all provided good indicators, but in New York State we have also asked each institution to establish its own advisory panel in commerce and industry at the local level to help in planning, operating, and evaluating their programs. We feel that these local panels can be of great help in the evaluation process.

Eventually, these institutions and their services and projects will develop reputations, good or bad, in their respective communities with respect to the technical services they provide. Those institutions which establish good reputations will find their services in demand.

Although New York State was one of the first to establish a program under the act, our oldest projects have been in operation for only 1 academic year. In several cases, work started earlier in this calendar year, 1967.

The establishment of closer relationships between industry and these fine institutions for technology transfer will not be accomplished in 1 year. The best promise of success for the New York State program will come through the improvement of these relationships.

Adequate funding of the institution appears to be our principal problem in fiscal year 1968.

Thank you very much for this opportunity.

Mr. O'Connor. Mr. Carpenter, do you have any questions?

Mr. Carpenter. To continue Senator Randolph's inquiry on this manpower, I wonder if all of you might comment on some of the possible sources of manpower to staff the transfer agent function.

Do you have any information as to whether the existing State and county staffs can be trained adequately to do this or whether university staff members on a part-time basis are being successful in talking to small businessmen on the basis of day-to-day problems or whether retired people can be used efficiently?

And then to sum up this question, just how many full-time transfer agents do you think you would need in your State?

Mr. Larson. May I take that question?

Mr. Carpenter. Please do.

Mr. Larson. In the first place, in New York State, the designating agent is not a participating institution. We do not have an inventory of information, and we do not do the contact work. We do our work entirely by contracts with the educational institution in the State. They recruit and provide the people involved.

In most cases, where the program is to be successful, they have acquired at least one full-time man to do the work. They call on the

regular faculty of the engineering schools for part-time assistance as they need it.

They may negotiate subcontracts with other agencies or institutions within the area or within the technology involved.

We are trying, therefore, to make use of existing people for the Office of State Technical Services at the institutions. However, there have been recruiting problems. In some cases, retired military officers have been used for this work, with some success. In other cases, retired faculty people have been used. In some cases, relatively young people have been recruited successfully by the institutions to man those offices.

Dr. HEDDEN. In one sense, we have not had very much of a problem on the recruiting, because the budget has been so small at this point.

However, we have one excellent example of the use of a person who has retired. He is from Wisconsin. He is in the room with me. He has done a remarkable job.

We are firmly convinced that there is much talent here that can be used very effectively. The numbers that we can get are probably very small.

There is another area that serves a somewhat different function, and that is the county resource agent. There is some effort in Wisconsin to change the stripes, so to speak, on the county agent in our industrial areas, to convert him to a resource man or an agri-business agent who has a little more touch with the business community than the agriculturally based agent formerly did.

I think we can say that there are on the order of a half a dozen in Wisconsin—I am not sure of the exact number at the moment—that are operating in this way. We have excellent contact with these people. They have taken an active and aggressive interest in serving this need. We do not expect that they will become experts in the technologies, but they are good people, because they know their local communities well. They are in a position to influence the business management in their communities to seek the appropriate sources of expertise, which we can provide at the university. When we get to the more technical areas, our technical staff on the campus will be very helpful. In some cases, they have volunteered a certain portion of their time without any cost to our program or to the State, except that their salaries are paid. There are six people on the university staff at Madison whose salaries are paid to do specifically this job of being, in a sense, specialists who discuss the problems of more advanced technology with the businessmen in the State. And this is also proving to be effective, but it is limited in scope, and we have just a small number of these that we can afford to fund this way. This is not funded under the STS program but is a part of the contribution of the State institutions.

Mr. CARPENTER. Mr. Peyton?

Mr. ANGUS PEYTON. I only want to make a few remarks on that and then turn it over to Mr. Allen Peyton.

We have found that most of ours come from people who have been in the business world and know how to communicate. Usually these are retired people or people who have, for some reason or another, decided to make a change. Our former director was an engineer with an aircraft company in California who did an excellent job in this respect. He was a young man.

Our present director, Mr. Peyton, who is a retired colonel and was in Army ordnance work operating overseas in England and Denmark, and, basically, utilizing this same type of transfer of technological information from our Army to their armies. We are very fortunate to have him.

I believe that there is a new breed of person that we are going to have to recruit and train. I do not think that just anybody, particularly people from universities, will be able to move into the field and be taught to transfer this information. They possibly can be trained, but I think we need people with a practical background who know how to read and keep up with the latest information, but who, in turn, can transfer this information. I do not have any solution of the problem, but I know we have difficulty in finding this particular type of person.

Mr. Peyton?

Mr. ALLEN PEYTON. I agree with the commissioner. You asked the question about what type of person we need. First of all, I certainly agree with the commissioner that in most cases the academician is not the man we need, because in many cases he has a philosphical or academic attitude, and he is not the down-to-earth man that we want. We need a man who can communicate. We need a man who is a generalist rather than a specialist. I think our traditional engineering disciplines such as chemical and mechanical, and so forth, are not the people we need because they are trained in one specific discipline. If you go to your engineering discipline, I think that probably the man you would want would be the industrial engineer.

And, incidently, the young man that the commissioner mentioned, the former head of the program in West Virginia, was an industrial engineer, and this is one reason he did such a good job. He had a broad background rather just a single-discipline training.

He was also able to communicate, which is required.

And you have to have empathy. This is a characteristic that you have to have.

It is very easy in this work to say, "Well, now, we can make a great big record, because we can put all of this information on computers, and we can distribute 10,000 reports a week; so look at what we are doing." This is not what we are after. You need people who understand this.

So, my own personal feeling on this is that, generally speaking, with all due respect to Dr. Hedden, because I do not think he is an academician in the first place, although he is with the university, the academician is generally not the man we want.

Mr. CARPENTER. Mr. O'Connor?

Mr. O'CONNOR. I would like to revert briefly to the statement in Commissioner Peyton's presentation on page 11. There, Commissioner, you made the point that the act has been interpreted not to embrace the transfer of the new management techniques, and the like. Of course, in that connection, the Small Business Administration, as I am sure you are aware, has for some years had a fairly aggressive management advisory program. They publish "how to" pamphlets, and hold seminars throughout the country, and conferences which are all more or less geared to improving the management

capabilities of small firms. And, so, I wonder if, in view of that, you still feel that it would be, not perhaps duplicative but a further breakthrough if the act were broadened so that management techniques can be disseminated through this program?

Mr. ANGUS PEYTON. I am merely speaking from the viewpoint of West Virginia and the real need for management skills in the development of these techniques. I do not say that the State Technical Services Act is the one to provide this. From the experience that I have had with most of the other programs, to me this is a logical place for it to be. To me, this is as important as, almost, a transfer of specialized technical information to these firms. In order to assimulate and understand these technological changes, they also need to upgrade their own management skills and understanding.

I can only say that we recommend this, because we feel the need for it.

Mr. ALLEN PEYTON. I would like to add this: Technology transfer is difficult, and it is not a case of, in all cases, just transferring a specific piece of technology. And I would like to use an example, perhaps an oversimplification. You might contact a small businessman in the machine shop business, and he might say: "I am having trouble in meeting my demands, and I have all kinds of problems. I know my equipment is old. I just can't get enough machinists," and so forth.

So, you might say to this man: "Well, one reason is that you are not using modern equipment. You can do twice or three times as much work if you use numerically controlled machines." And this is true.

He goes out and makes an investigation of numerically controlled machinery and buys it; and he comes back 30 days later and says: "I am still not meeting my demands. You told me the new machines would do it."

Well, the reason was not that his equipment was too old. His problem was that he was not getting the product out of the door to the customers in the quantities required.

So, the door is where you start. When you put the machine in, probably if his material-control system, his inventory-control system, his material-handling equipment, or his material-handling system, and so forth, is not changed at the same time—in other words, this is not approached on a systems basis, you may not have helped the man. And so these things he has to understand.

Now, this machinist can understand that a new piece of equipment will do a good job, but you have to convince him that it also takes a cost-accounting system, and it takes a materials-handling system, and an inventory-control system. And these are the things which we should be able to convey to this man, not just on a one-problem-at-a-time basis, but on a systems basis.

Mr. O'CONNOR. To Senator Randolph's expression of appreciation for your contribution, for your appearance, I will only add that copies of the stenographic transcript will be made available to you. Of course, when the subcommittee prints the report on the hearings, you will automatically receive a copy.

Thank you very much, gentlemen.

We will stand adjourned.

(Whereupon, at 11:40 a.m., the subcommittee adjourned, subject to the call of the Chair.)

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(Prepared by Migdon Segal, Science Policy Research Division, Legislative Reference Service, Library of Congress)

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