A BY-PRODUCT OF NASA: TRANSFER OF NEW TECHNOLOGY TO VARIOUS SECTORS OF THE ECONOMY

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ABSTRACT

The purpose of this study is to examine the various processes of technology transfer currently being utilized by NASA with the intent of extracting knowledge learned to date concerning the technology transfer process and to describe areas where additional effort is required.

Methods of technology transfer for both formal technical publications and other informal publications are examined. Services available to both the aerospace industry and the civilian economy are reviewed. Shop- or production-orientated innovations as well as new scientific technology are considered. Patent opportunities in terms of licenses and waivers available to the civilian economy are also examined.

Results indicate that the system of publications, computerized storage and search services, and other processes for transferring technology to both the aerospace industry and civilian industry are highly successful in spite of its complexity and relative newness. NASA patent and licensing policy appears flexible and well geared for effective technology transfer. The policy of "soft-sell" concerning publicity about technology transfer activities is a problem in that only a few technical innovations get publicized, and one of the major benefits of the space program is hidden from the general public.

A BY-PRODUCT OF NASA: TRANSFER OF NEW TECHNOLOGY TO VARIOUS SECTORS OF THE ECONOMY

PART I.

INTRODUCTION

I. AEROSPACE RESEARCH AND DEVELOPMENT

Importance of Aerospace Research and Development

It has been stated that the space program is a tool for the solution to complex problems confronting human society and is a producer of knowledge, new products, heroism, greater national security, and a larger gross national product.[1] In virtually all industries, the impact of space-connected research and development has been felt in products ranging from razor blades to television circuits. Despite these advances, there is an "understanding gap," that is, an awareness of a vast program but not a general understanding of how the space program does help both the public and the economy.[2] The "understanding gap" is the result of an incomplete transfer of space-connected research technology and knowledge to various segments of the economy. It is this problem of technology transfer from the national space program which is the subject of this study.

Aerospace research and development influences technology advancement within the space-defense industry itself. Accurate assessment of technology advances is an important aspect of the overall marketing effort of the modern aerospace firm. The gathering, evaluating, and cataloging of both technical information and

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[1] Hubert Humphrey, "Message from Vice-President Humphrey," Technology Week, XX (June 5, 1967), p. 21.

[2] Ibid.

marketing data is required such that forecasts are realistic and new product opportunities are identified. Proper relation of the firm to the larger outside environment by balancing technical capabilities with customer desires has only recently been recognized by the aerospace industry and incorporated into current marketing practices as described in the appendix.

External to the aerospace industry is the requirement for accurate assessment of technology advances by the civilian sector of the economy. Technology is advancing more rapidly in the space-defense sector of the economy than in the commercial sector.[3] As a result, it is increasingly important that the civilian economy make maximum usage of Government-financed aerospace technology advancements. It is required that the general public as well as industrial users be adequately informed of technology advances. Only if the public at large, including aerospace and civilian industry employees, is aware of the importance of aerospace research and development can future support and utilization of the knowledge be assured.

The Problem of Technology Transfer

Recognition of the problem of technology transfer dates back to the Constitutional Convention. The framers of the Constitution were well aware that European governments in the eighteenth century had often supported scientific and technological endeavors. The

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[3]Walter Wentz, "Aerospace Discovers Marketing," Journal of Marketing, XXXI (April 1967), pp. 27-31.

[4]Wroe Alderson and P. E. Green, Planning and Problem Solving In Marketing (Homewood, Ill.: Richard D. Irwin, Inc., 1964), p. 201.

fear existed that the new nation would not have the capital, the science, or the technology to compete with the well-developed European countries. One proposal to provide the technological base for industrial growth was known as the "grand plan." The intention of the plan was the establishment of a national university devoted to advanced technical education and to a national program for the dissemination of technical information. Though the "grand plan" was not adopted, the debate about it marked the beginning of a pattern of Governmental concern with the rapid and effective diffusion of scientific and technical knowledge which has continued throughout our history. One early example of Government participation in the technology transfer process was the direction by the Secretary of State, Thomas Jefferson, that instructions for building an evaporator be printed at Government expense and distributed to all shipmasters shortly after the first patent law was passed in 1790. There is a long list of specific actions by the Congress which give substance to the principle of federal support of science dissemination programs. The best known effort is that of the Department of Agriculture which has been so successful that at times our farm industry's productive capacity has outstripped its market. 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. More recently 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."[5]

Today, technology transfer activities must deal with the large amount of scientific and technical information produced by the world's laboratories. Thousands of new ideas and cost saving devices are hidden away. As a result, there is much duplication because even the scientist cannot keep up with the material in his own field of work.[6] Much of the space-related technology and capability is unexplored in the civilian sector of the economy because of the lack of initiative and understanding.[7] It is important that the civilian sector of the economy realize that new products have roots in new technical opportunity arising out of the results of research as well as from consumer demand. As product life cycles become shorter because of technical progress, it becomes increasingly important that new product decisions be made in the shortest possible time period. This implies that the technology transfer process must both be rapid and in a form which expedites evaluation. The problem is further complicated by the fact that knowledge must reach the key people who influence decisions to use a new idea or develop a new product as well as the general public who support the aerospace program. It has been said that the technology transfer efforts of NASA have

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[5]U.S., Congress, Senate, Subcommittee on Science and Technology of the Select Committee on Small Business, Statement of Richard L. Lesher, Assistant Administrator for Technology Utilization, National Aeronautics and Space Administration, September 27, 1967.

[6]Ted Stanton, "Fishing for Facts," Product Strategy and Management (New York: Holt, Rinehart, and Winston, Inc., 1963), pp. 430-433.

[7]Wentz, pp. 27-31.

been extremely successful in some areas and severely lacking in others.[8] It is the purpose of the research described in this paper to examine the various processes of technology transfer currently being utilized by NASA. The intent of this research is to extract knowledge learned to date concerning the technology transfer process and to describe areas where additional effort is required.

The material contained in this paper is based on Government sources and documents as well as information available to the general reader. To date, there is considerable documentation of specific portions of the technology transfer process from Government and secondary sources, but little is available to the general reader. The scope of this investigation will include the total technology transfer program used to disseminate technical information to (1) the aerospace industry itself, (2) the civilian sector of the economy, and (3) the general public. Included in the following chapter are definitions of the types of research and development and the types of recipients followed by discussion of the technology transfer process as a total integrated activity. Part II describes the various methods of technology transfer and includes technical publications, informal publications and services, and patent licenses and waivers. Part III provides for summation of the technology transfer program with conclusions and recommendations based on the material contained herein.

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[8]U.S., Congress, House, Subcommittee on Advanced Research and Technology of the Committee on Science and Astronautics, Representative Frey's comments concerning statement by Richard L. Leshner, Assistant Administrator for Technology Utilization, National Aeronautics and Space Administration, March 13, 1969.

II. DEFINITIONS AND CONCEPTS

Types of Research and Development

Various authors have initiated various definitions for the terms "research" and "development." For instance, Travis[1] defines the total research and engineering activities in developing a new product as consisting of the following phases:

(1) Research

(2) Technical development

(3) Pre-project study

(4) Engineering model development

(5) Production prototype

In this case, the term "research" refers to only those activities in which new knowledge is derived beyond the state of the art. "Technical development" applies to only those activities which create new functional results by application of a combination of known facts. More general and commonly accepted in the aerospace industry is the terminology used by Weidenbaum[2] who describes the types of research and development as follows:

(1) Basic research

(2) Applied research

(3) Development

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[1]Irven Travis, "Developing the New Product," American Management Association Marketing Series, 101.

[2]Murray Weidenbaum, "The Military Research-and-Development Market," Journal of Marketing, XXV (April 1961), pp. 38-41.

"Basic research" is those activities which provide fundamental facts beyond the state-of-the-art of human knowledge, and "applied research" is those activities which suggest practical application of basic knowledge. The product form of both basic and applied research is usually facts, concepts, ideas, or theoretical models, termed "software." "Development" refers to the systematic use of scientific knowledge directed toward the production of a system. The final three phases of Travis' model are encompassed in the "development" process. The product form is usually "hardware," i.e., mechanical gadgets, but the end product of the "development" process may also be "software" such as a sophisticated technique for predicting future needs or a computer program. For purposes of this paper, the definitions given by Weidenbaum are used because of their general acceptance in the aerospace industry.

Research and development activities are performed by both Government laboratories and industry companies as shown in figure 1. Over 50 percent of those activities performed by industry are directly financed by the Government, however.[3] This class of information is distributed to the appropriate taxpayers in the same manner as that technology derived in Government laboratories. Company-sponsored research and development technology is proprietary information and may be used in developing a new product for the consumer, Government, or industry. This paper will limit itself to those technology transfer activities usually performed in connection with Government-performed or Government-sponsored research and development technology.

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[3] Ibid.

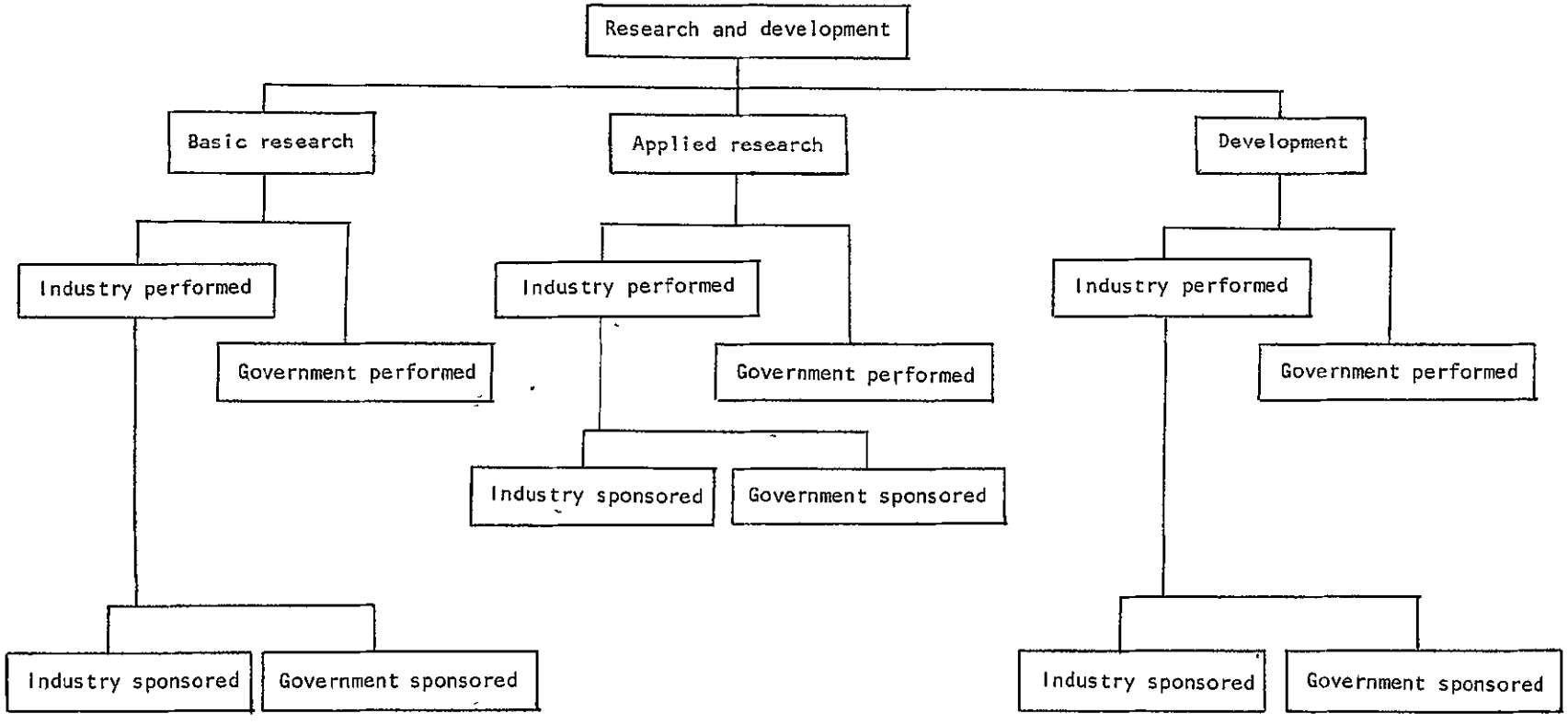

Figure 1.- Types of research and development.

However, many of the activities described are used for the promotion and distribution of company sponsored research and development technology.

Types of Recipients

The types of recipients for aerospace research and development technology may be divided into three general classes. These classes are (1) the aerospace/defense industry itself, (2) the civilian section of the economy, and (3) the general public at large. The various organizations and groups which comprise these three classes are shown in figure 2.

The aerospace/defense industry itself is the largest recipient of research and development technology and has been described as one of the major growth markets in recent history.[4] This is not surprising when one realizes that justification for research and development activities is derived in the first place from the needs of the nation's defense, aviation, and space activities which are monitored by various federal agencies. Often it is quite difficult to separate military and space activities from civilian industry because some equipment is used in both sectors of the economy. For instance, improvements concerning military transport aircraft affect the airlines which fly similar aircraft, and developments in atomic power generators influence utilities companies which use similar concepts. For this reason, activities by the Atomic Energy Commission and civilian aviation manufacturers are included under both the aerospace/defense industry and civilian industry classes.

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[4] Ibid.

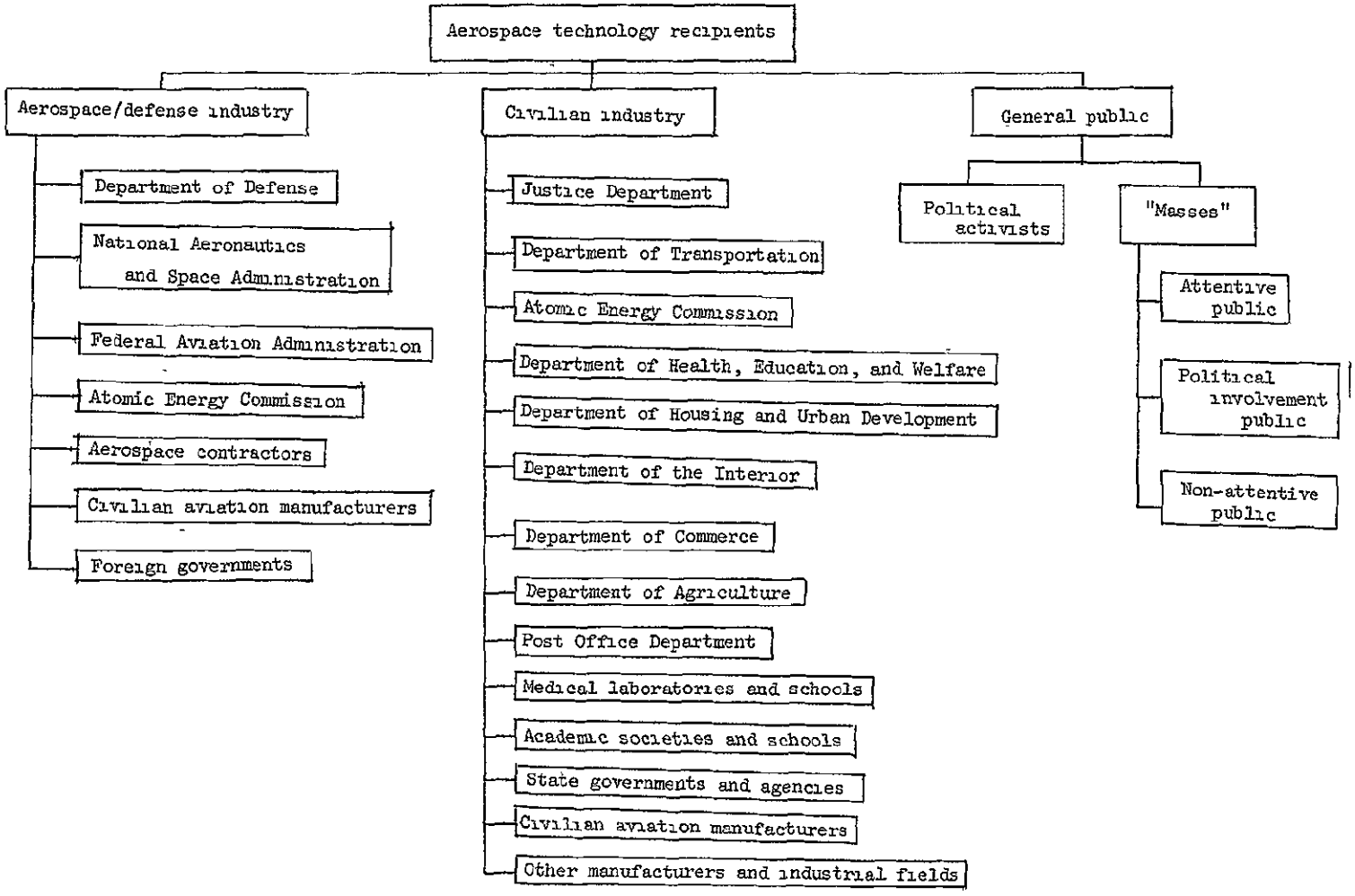

Figure 2.- Types of recipients.

The civilian sector of the market comprises both federal and state government agencies as well as medical and academic activities in addition to other civilian industry. For example, the Department of Transportation is becoming a burgeoning market for research and development firms because of its activities concerning traffic congestion control, highway safety, and oceanographic research under the U.S. Coast Guard. Aerospace derived management skills are required because of the complexity and magnitude of nuclear power, radiation utilization, and excavation projects within the Atomic Energy Commission. Research and development activities in medical technologies, education, and air pollution are limited only by budgetary constraints in the Department of Health, Education, and Welfare. The Department of Agriculture has valuable uses for remote sensing techniques developed for space use in their projects.[5] In addition to the market within the federal government, there is vast potential within other civilian industries. In its attempts to diversify, the aerospace industry has seen opportunities in the fields of medicine, communications, meteorology, topography, and oil exploration. Success is not always easy because of economic misunderstanding, however.[6] In the future new civilian markets in foreign countries may also become available if the cooperative research programs between foreign countries and the United States Government in the aerospace/defense industry are successful.

Consideration of the general public as a recipient of aerospace research and development technology is necessary to insure the future.

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[5] Technology Week, XX (June 5, 1967).

[6] "Oilmen Wary of Aerospace Promises," Technology Week, XIX (September 26, 1966), p. 27.

Congressional support is required for funding, and in the long run, political activity will merge with public opinion. It is then necessary that proper technology transfer activities take place such that the general public is aware of the value of aerospace research and development. When considering the general public, it is necessary to evaluate the influence of various segments of the population. Many methods are available for dividing the population into segments. For purposes of this paper, the method of Key[7] is adapted. The general public is considered to be made up of political activists and the "masses." The political activists are those persons actually engaged in political activities and include persons in the highest political offices (such as the President and congressmen) down to the vote getters and helpers in political campaigns. The "masses" consist of the attentive public, the political involvement public, and the nonattentive public. The attentive public has a continued interest in politics, follows all events closely, and often writes their congressman. Farmers, retired people, corporate heads with financial interests, associations, and professional groups and societies comprise the majority of this group which is less than ten percent of the total "masses." Division between the attentive public and the political activists must be considered a "gray" zone because precisely where political participation begins cannot be defined. Bounds between the attentive public and the political involvement public are also "gray." The latter is considered to "care" and have an interest in politics but is not as well informed as the attentive public. Finally at the bottom of the scale is the nonattentive public which does not bother to vote or keep up with political events. The

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[7]V. O. Key, Jr., Public Opinion and American Democracy (New York, Alfred A. Knopf, 1963), pp. 535-558.

area between the nonattentive public and the political involvement public is also "gray," but it is considered that only ten percent of the "masses" comprise this inactive group.[8] Thus it is required that the technology transfer process consider the political activists and at least ninety percent of the "masses" if the future of the aerospace research and development program is to be insured.

The Integrated Activity Concept

The process of transfer of research and development technology from laboratory to user is a many-sided problem. Clearly the situation represents a complex problem in communications in that the language of the scientist must be converted into that of the manager, financier, or layman as well as to other scientific disciplines. A form must be used which expedites evaluation. The transfer process may also be viewed as a promotion problem in that some device is required to make the recipients aware of the availability of specific technology advances. In view of the large amount of scientific knowledge being generated by the world's laboratories, it is evident that a sophisticated system is required which advertises the various technology advances before a wide spectrum of recipients. Finally, the knowledge must reach key individuals who influence decisions as well as the general public who support the aerospace program. This implies the requirement for an extremely versatile program of distribution. Thus, the effective technology transfer program must combine the principles of communications, promotion, and distribution into an integrated activity which is both available to and

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[8] Ibid.

economically feasible for prospective users. Such a program is required for the national interests because the dizzy pace of scientific progress now threatens to cancel experience as a decision factor when humans deal with their environment.[9]

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[9]John Judge, "Department of the Interior: Water Pollution, Conversion Pose Great Problem," Technology Week, XX (June 5, 1967), pp. 46-51.

PART II

METHODS OF TECHNOLOGY TRANSFER

III. TECHNICAL PUBLICATIONS

NASA Organization for Publication Activities

The transfer of technology from the national space program to various sectors of the economy is directed by the Office of Technology Utilization within the NASA Headquarters organization shown in figure 3. Under the Office of Technology Utilization are two divisions concerned with transfer activities both within and external to the aerospace community as shown in figure 4. The Scientific and Technical Information Division is concerned with the dissemination of formal technical publications to the aerospace community. The activities of this division are the subject of this chapter. Technology transfer outside the aerospace community in the form of special classes of informal publications, formal technical reports, and special services is the concern of the Technology Utilization Division. Activities which provide technology to the civilian sector of the economy are part of the Technology Utilization Program and is managed by the Technology Utilization Division. Technology Utilization Division activies are the subject of chapter IV. The Management Systems Division is a programing group which provides management computerized system support to various offices within NASA Headquarters and is not directly concerned with the technology transfer process at the present time.[1] Activities of this group

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[1]John Samos, Technology Utilization Officer, NASA Langley Research Center, private interview, October 21, 1969.

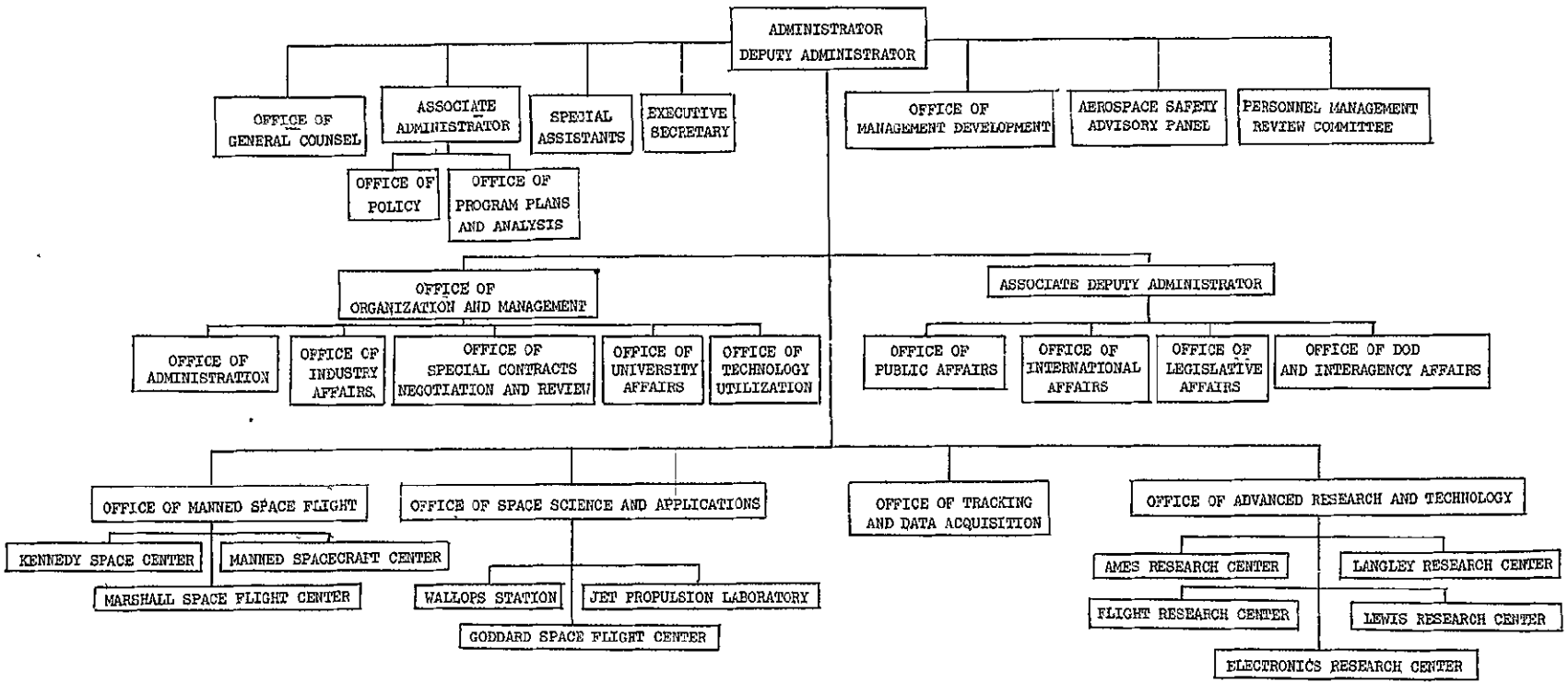

Figure 3.- National Aeronautics and Space Administration organization chart.

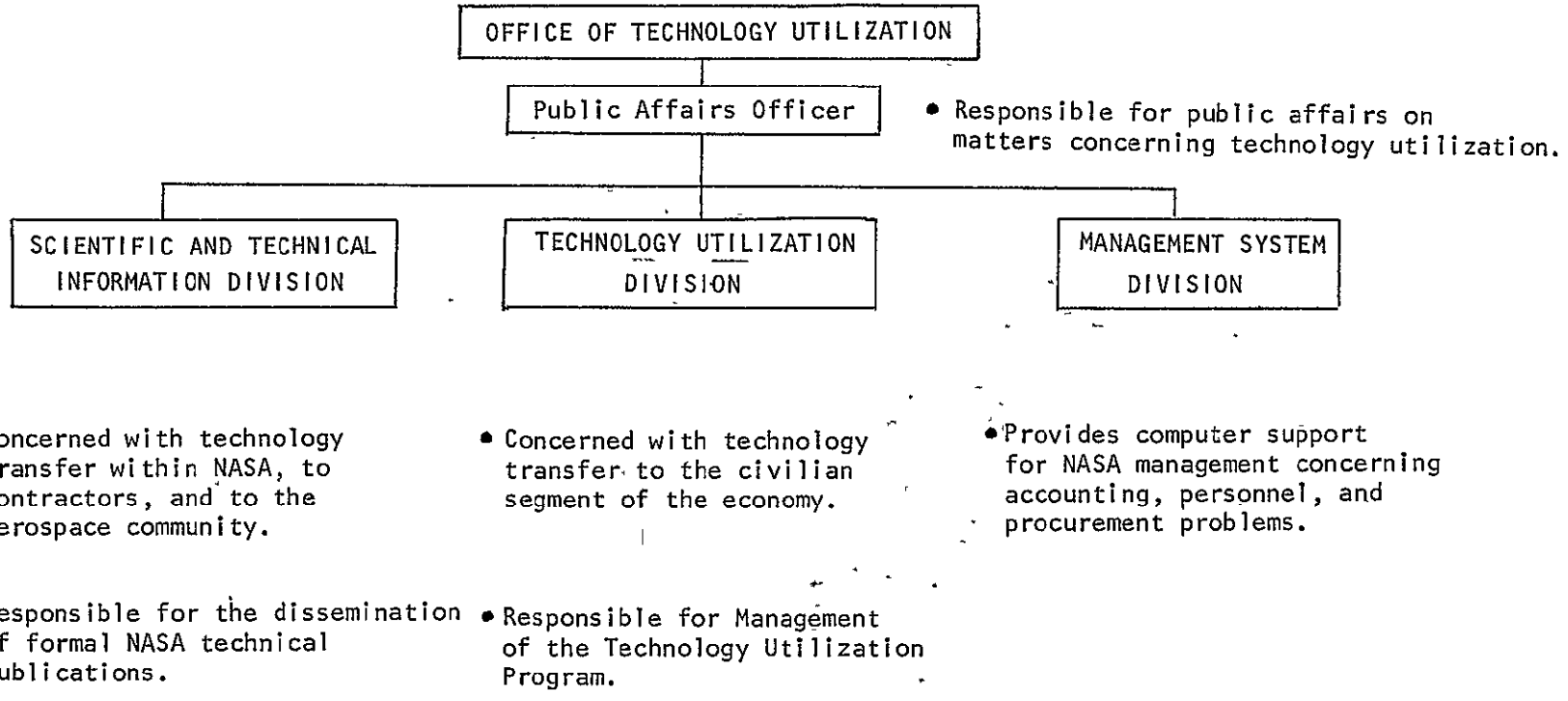

Figure 4.- Office of Technology Utilization organization chart.

will not be considered in this study. Also located within the Office of Technology Utilization is a Public Affairs Officer who is concerned with the publicizing of the technology transfer function to the general public. Activities of the Public Affairs Officer and coordination with the Office of Public Affairs are discussed in chapter IV.

Formal technical reports and scientific journal articles are the traditional mechanism of technology transfer within the aerospace community. These reports and journal publications originate from NASA, other Government agencies, major professional societies, industry contractors, and foreign governments. The Scientific and Technical Information Division is concerned with making these formal publications from all sources available to the aerospace community. Thus procedures for identification, recording, and dissemination must be applicable to both formal NASA publications as well as published documents from external sources. The activities of the Scientific and Technical Information Division which provide technical publications to the aerospace community are in a constant state of transition. As new systems or techniques are tried, the total system is updated based on successful experiments. Thus, the activities described herein represent the system in its present status. As new knowledge and machinery become available, portions of the system may be expected to change, particularly in the area of retrieval and search activities.

Publication Activities

Identification of New Material

NASA has been discovering new things about materials, machinery, and human beings, as well as about the Earth, the Moon,

and the universe since 1958. The information and data collected have been made available to prospective users through the variety of technical publications shown in figure 5. All of these documents are considered as formal publications which are bound and distributed to various libraries and organizations throughout the country. The technical reports, technical notes, and technical memorandums are the fundamental publications of NASA which report the majority of new technology. Knowledge gained by industry under NASA contract is distributed through the use of contractor reports when the value and scope of the contribution warrants national distribution. Special publications are used to distribute information not covered in the scope of reports, memorandums, or notes, and technical translations are utilized for dissemination of important foreign discoveries.

Identification of what technology should be published is considered an important activity within every NASA installation. To insure the quality of material and to decide the proper type of publication, a rather complete procedure for editorial review of all technical publications is utilized. Figure 6 shows a typical review procedure for a prospective NASA technical publication. The procedure is essentially the same no matter which NASA installation the publication is originated. Usually the most difficult step of the process is the review by four to six scientists or engineers at the same installation and in the same area of work as the author. The final document is usually as near perfect as a human being and the state-of-the-art can make it. In the case of special publications, contractor reports, and technical translations, the editorial process is adjusted to fit the special needs of these publications.

I. NASA Technical Reports - Scientific and technical information considered important, complete, and a lasting contribution to existing knowledge.

II. NASA Technical Notes - Information less broad in scope but nevertheless of importance as a contribution to existing knowledge.

III. NASA Technical Memorandums - Information receiving limited distribution because of preliminary data, security classification, or other reasons.

IV. NASA Special Publications - Information derived from or of value to NASA activities. Publications include conference proceedings, monographs, data compilations, handbooks, sourcebooks, and special bibliographies.

V. NASA Contractor Reports - Scientific and technical information generated under a NASA contract or grant and considered an important contribution to existing knowledge.

VI. NASA Technical Translations - Information published in a foreign language considered to merit NASA distribution in English.

Figure 5.- Types of formal NASA publications.

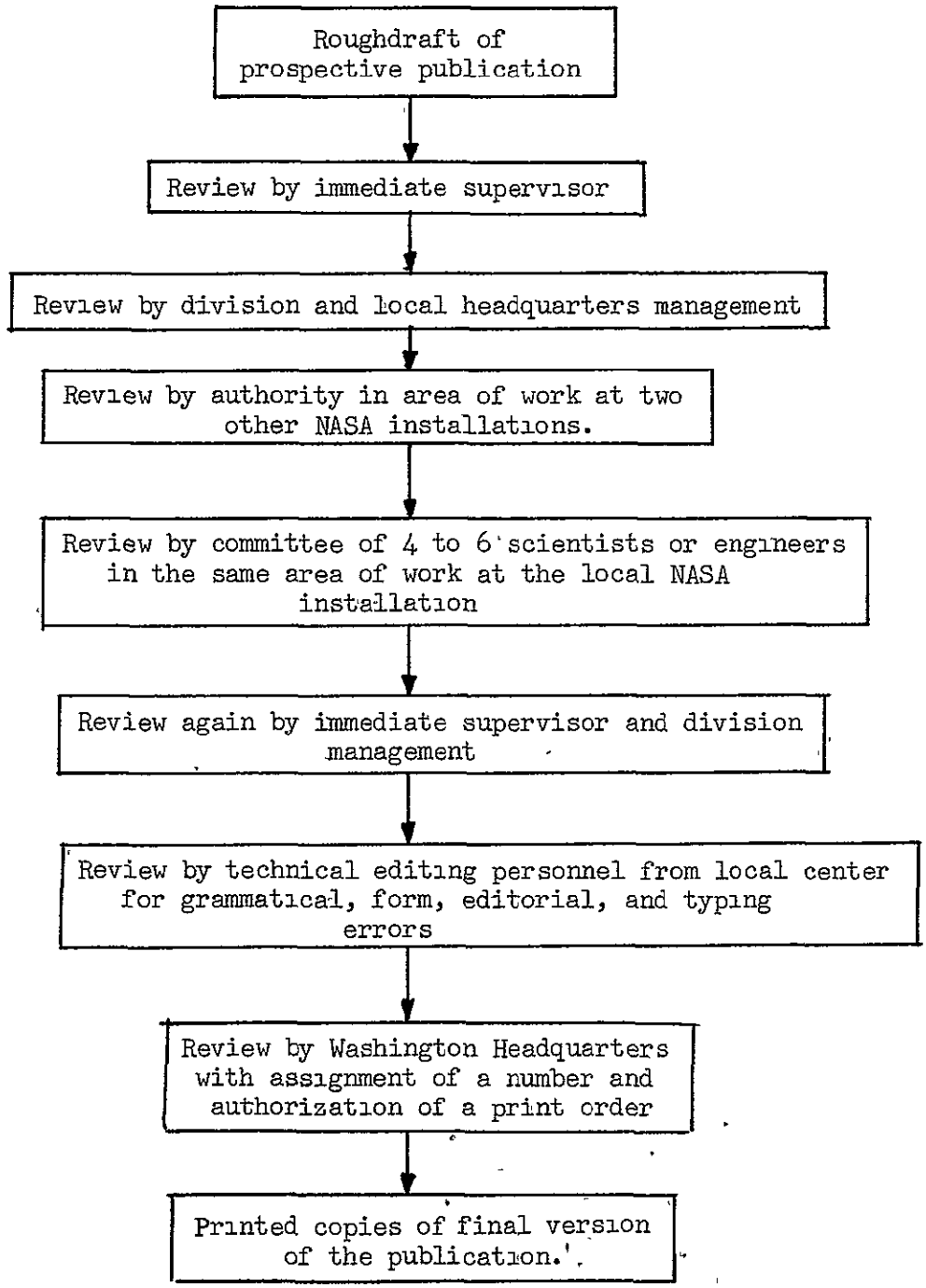

Figure 6.- Typical review procedure for a prospective NASA publication.

For technical publications originating outside NASA, identification activities consist primarily of agreements to be furnished with certain types and classes of technical documents. The actual editorial and screening process is left to the organization originating the document for the most part. Upon arrival to NASA, each document is summarized and indexed. They are promptly checked to avoid duplication, examined for relevance, and cataloged descriptively. Professional indexers examine each item, document the bibliographic data that accompanies it, and select terms under which it is listed in subject and other indexes. Trained abstractors read the abstracts submitted with documents, sometimes edit and condense these summaries, and write abstracts of documents which have been received without them. Each document accepted as a potentially valuable contribution is then given an accession number by which it can be quickly located in the future.[2]

Recording and Storage of Documents

Technical publications both from within NASA and from external sources are recorded for storage and future dissemination by use of microfiche copies. Microfiche copies are four- by six-inch film transparencies that contain up to seventy papes of information which may be distributed for reading on a special viewer or reproduced as a full-size hard copy. Figure 7 shows a typical microfiche copy of a technical document. Reduction of all technical publications to small film copies has the purpose of satisfying both storage requirements and document requests with maximum economy. One file cabinet of

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[2]The NASA Scientific and Technical Information System and How to Use It, National Aeronautics and Space Administration, 1969. (Pamphlet.)

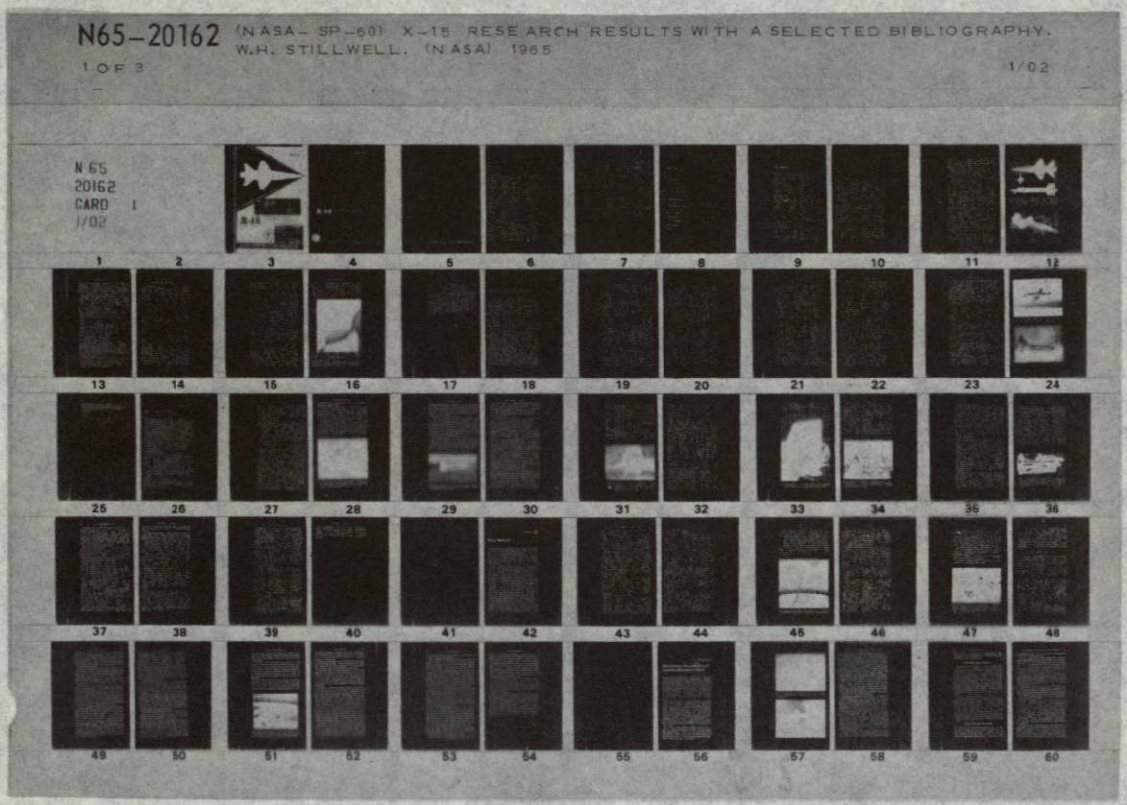

Figure 7.- Typical microfiche copy of a technical report.

microfiche may contain the same documents as eight to ten bookcases[3] which represents a space saving of a factor of ten to twenty. Microfiche copies are also easily sent through the mail for viewing or reproduction by the recipient.

Recording and storage of the physical document is only one phase of the total recording and storage process. It is also necessary that the document be recorded and stored into some cataloging system such that a recipient may be made aware of its existence. For NASA, the catalog is a high-speed electronic computer operated by Documentation, Inc., at the NASA Scientific and Technical Information Facility at College Park, Maryland. Twice a month, complete bibliographic records of new documents are placed on updated computer tapes, copies of which are sent to various organizations across the nation. Figure 8 shows the list of recipients of computer-tape indexes as of 1967. They include the NASA installations, the Regional Dissemination Centers[4], the larger NASA contractors, and special cases representing national and international cooperation. Each tape user operates a subsidiary central facility through which he may search for documents containing specific types of information. Not all users receive the same tapes. For example, the Regional Dissemination Centers, the European Space Research Organization, and the Clearinghouse for Federal Scientific and Technical Information receive tapes reflecting only unclassified and unlimited information.

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[3]John F. Stearns, "Scientific and Technical Information," Presented at a program for NASA executives, February 1967. (Pamphlet.)

[4]Activities of the Regional Dissemination Centers will be discussed in chapter IV.

NASA CENTERS:
- Ames
- Goddard
- Kennedy
- Langley
- Lewis
- Manned Spacecraft
- Electronic Research
- Jet Propulsion Laboratory
- Redstone Arsenal

REGIONAL DISSEMINATION CENTERS:
- U. of So. Calif.
- U. of New Mexico
- N.C. Sci. and Tech. Res. Ctr.
- Indiana U.
- U. of Pittsburg
- U. of Connecticut

R&D CONTRACTORS:
- Aerojet General
- AVCO-Wilmington
- AVCO-Everett
- Bellcomm
- Boeing
- Douglas
- General Dynamics
- General Electric
- Goodyear
- Grumman
- Hughes
- Lockheed
- North American
- Republic

SPECIAL USERS:
- European Space Research Organization
- Chemical Propulsion Information Agency
- Clearinghouse for Federal Scientific and Technical Information
- Defense Documentation Center

Figure 8.- Recipients of computer-tape indexes.

Dissemination of New Publications

Announcement medium.- Two complementary abstract journals are used to announce the contents of the NASA scientific and technical information system. The journals are the Scientific and Technical Aerospace Reports (STAR) and the International Aerospace Abstracts (IAA). The abstracts in STAR cover technical report literature and represent the most recent updating of the Scientific and Technical Information Facility's computer-tape indexes as described in figure 9. The IAA provides similar coverage for more formal publications such as foreign and domestic books, journals, proceedings, and other publications beyond the "report" level. IAA is issued by the American Institute of Aeronautics and Astronautics, a professional society, under contract to NASA. Both journals are issued twice a month and cumulative indexes are issued four times a year. The abstracts in each one are intended not merely to suggest the subject matter, but to summarize the significant findings and innovations reported. Both STAR and IAA are organized and indexed in basically identical ways. Subjects pertinent to a variety of disciplines are brought together in logical groups in the 34 categories shown in figure 10. A carefully structured indexing system further facilitates the use of each journal. Both STAR and IAA are indexed according to subject, author, and by contract number. STAR also contains a corporate source index, an accession number/report number index, and a report/accession number index. IAA is further indexed by meeting paper report numbers and accession numbers. The user is further aided by the code system of the accession number assigned each document which is explained in each issue of STAR and IAA. The accession number tells the reader

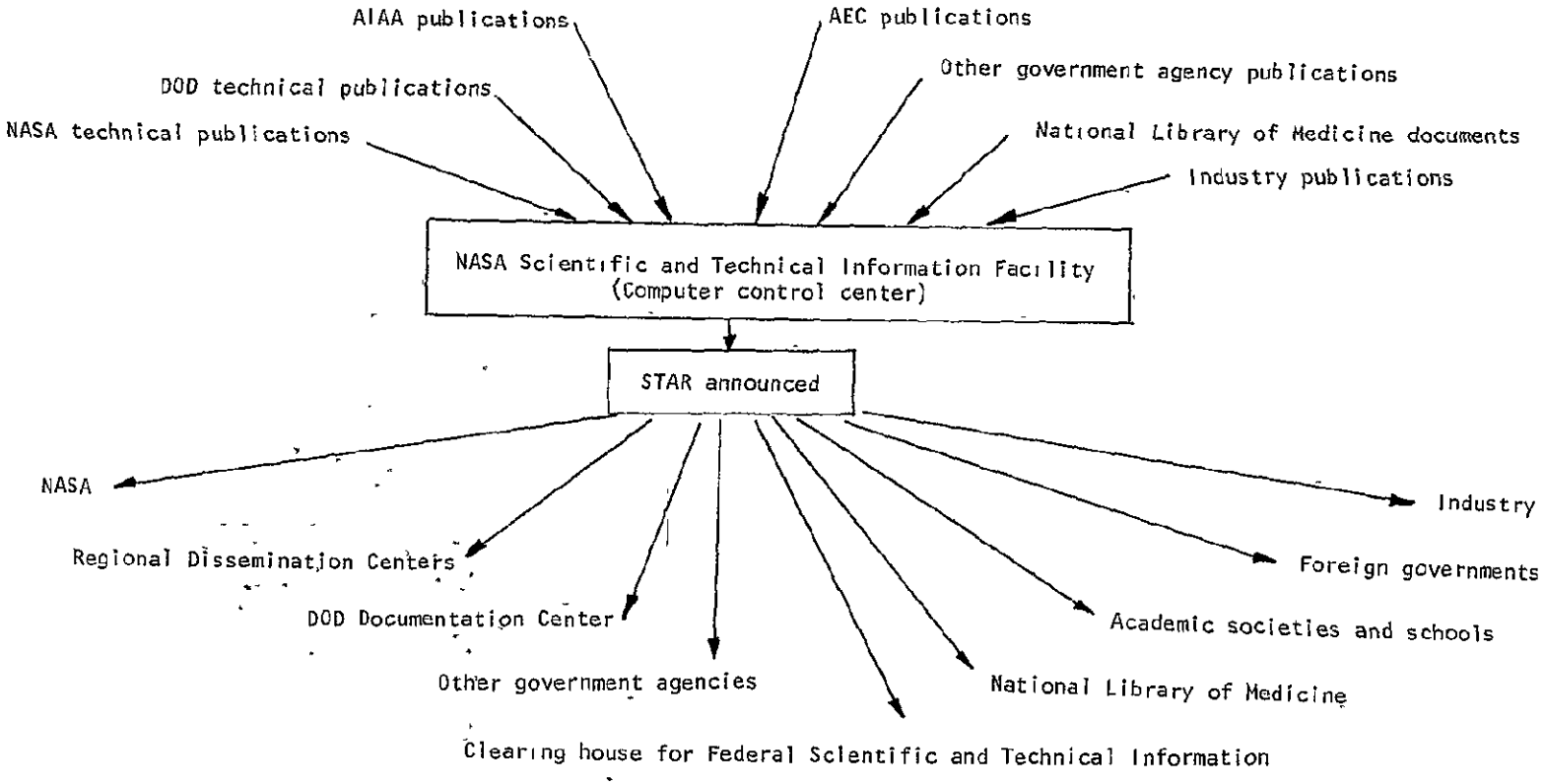

Figure 9.- Technical publication reference service.

01 AERODYNAMICS
02 AIRCRAFT
03 AUXILIARY SYSTEMS
04 BIOSCIENCES
05 BIOTECHNOLOGY
06 CHEMISTRY
07 COMMUNICATIONS
08 COMPUTERS
09 ELECTRONIC EQUIPMENT
10 ELECTRONICS
11 FACILITIES, RESEARCH, AND SUPPORT
12 FLUID MECHANICS
13 GEOPHYSICS
14 INSTRUMENTATION AND PHOTOGRAPHY
15 MACHINE ELEMENTS AND PROCESSES
16 MASERS
17 MATERIAL, METALLIC
18 MATERIAL, NONMETALLIC
19 MATHEMATICS
20 METEOROLOGY
21 NAVIGATION
22 NUCLEAR ENGINEERING
23 PHYSICS, GENERAL
24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR
25 PHYSICS, PLASMA
26 PHYSICS, SOLID-STATE
27 PROPELLANTS
28 PROPULSION SYSTEMS
29 SPACE RADIATION
30 SPACE SCIENCES
31 SPACE VEHICLES
32 STRUCTURAL MECHANICS
33 THERMODYNAMICS AND COMBUSTION
34 GENERAL

Figure 10.- Categories for STAR and IAA abstracts.

(1) whether or not there are restrictions on distribution of the report, (2) the year of announcement, (3) whether the document originated within NASA or not, and (4) whether or not the document is available on microfiche. Additional information besides the accession number and the abstract which are provided are the corporate source, the contract number, and whether or not the report is available from the Clearinghouse for Scientific and Technical Information.[5]

The frequency of publication of both STAR and IAA make each abstract journal both a current-awareness and a current-searching tool. The coverage provides the user with the most recent advances, what other organizations are doing on the subject, and what has been reported on a subject. The cumulative indexes published four times a year also provide the reader with a retrospective searching tool. Without going further than a nearby library, or possibly without leaving his office, the user can search technical literature extending back several years.

Retrieval and search services.- In addition to the retrieval and search tools provided by STAR and IAA, NASA also provides four types of computerized retrieval and search services. These services are (1) individual searches at the Scientific and Technical Information Facility, (2) individual searches at the nearest local recipient of computer-tape indexes, (3) selected current aerospace notices (SCAN) membership, and (4) remote console (RECON) searches.

Individual searches are requested through the local library for NASA personnel and contractors and through Regional Dissemination

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[5]Clearinghouse for Federal Scientific and Technical Information, Attention: Code 410.14, Springfield, Virginia 22151.

Centers for the public. Usually a fee is charged by the Regional Dissemination Centers. The advantages of the individual search is that the user specially tailors the bibliography of subject names to be searched.

SCAN is a special service to scientists and engineers serving NASA and its contractors. It differs from the individual search in that the topics searched are standardized. Every second week, a computer searches the latest reports received by the NASA Scientific and Technical Information Facility and the Institute of Aeronautics and Astronautics for data and information pertinent to about 200 topics. Biographic and indexing notifications are printed, duplicated, and sent to the several thousand individuals who are registered to receive this service. Each individual may receive notification on one or more topics of his choice from the standard topic list. Each person receives notification only of new findings because SCAN does not provide for retrospective searches. To receive any document listed on the notification, the user merely marks the notification and returns it to his local library.

RECON gives users hundreds of miles apart almost instant machine access to the central information store at the Scientific and Technical Information Facility. Seated at a console with a cathode ray tube and typewriter keyboard, the user may conduct an individual search of the computer in Maryland to meet his particular needs. The computer quickly responds by displaying the answer on the inquirer's cathode ray tube. If the user is interested in obtaining either all or some of the documents displayed, he can order the computer to print out citations for them which can be used by the librarian to

obtain the documents. Learning to use RECON is considered quite simple and instruction books are available for the novices. Retrospective searches as well as current searches are available using RECON.

The total retrieval and search services available to NASA personnel, their contractors, and the public are summarized in figures 11 and 12. Also shown is the method by which various users may obtain the services. In the cases of STAR and IAA, these publications may also be available at a local public or university library which is a channel of distribution.

Distribution channels.- Only publications originating within NASA or sponsored by NASA are distributed nationally on a systematic basis. Publications originating outside NASA are distributed to individual users by mail only after specific request. Hence, a consistent channel of distribution does not exist for non-NASA publications. For NASA publications, including STAR and IAA, mailing lists are the principle channel of distribution. All NASA installations, other Government agencies, contractors, and various organizations which request it comprise the mailing list. A large number of public, university, and other libraries are also on the list. Not all recipients receive all publications, however. Figure 13 lists the public libraries in which nearly complete collections of NASA publications are available. In addition, special libraries have been established which provide NASA technical documents and bibliographic tools. Figure 14 lists these locations. Each of these libraries is prepared to furnish to the general public services of individual searches, interlibrary loans, photocopies, and help in obtaining personal copies of NASA documents by microfiche if requested.

TYPE OF SERVICE	HOW OBTAINED BY NASA PERSONNEL	HOW OBTAINED BY NASA CONTRACTORS
STAR	Apply to NASA Scientific and Technical Information Division, Code USI, NASA, Washington, D.C. 20546	Register with NASA Scientific and Technical Information Facility, P.O. Box 23, College Park, Md. 20740.
IAA	Automatic if on STAR mailing list.	
Computerized literature searches and specially tailored bibliographies	Request from NASA Scientific and Technical Information Facility	Technical librarians of Government agencies and domestic universities. Write NASA Scientific and Technical Information Facility.
SCAN	Apply through NASA librarian	Apply at own library after registering with NASA Scientific and Technical Information Facility.
RECON	Apply at NASA library	

Figure 11.- Services available to NASA personnel.

TYPE OF SERVICE	HOW OBTAINED
STAR	Purchased from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
IAA	Purchased from AIAA, 730 Third Ave., New York, N.Y. 10017
Computerized literature searches and specially tailored bibliographies	Obtainable through NASA Regional Dissemination Centers on a fee basis. Apply for information to Director, Technology Utilization Division, (Code UT), NASA, Washington, D.C. 20546

Figure 12.- Services available to the public.

CALIFORNIA: Los Angeles, San Diego

COLORADO: Denver

CONNECTICUT: Hartford

DELAWARE: Wilmington Institute Free Library

MARYLAND: Enoch Pratt Free Library, Baltimore

MASSACHUSETTS: Boston

MICHIGAN: Detroit

MINNESOTA: St. Paul, Minneapolis

MISSOURI: Kansas City, St. Louis

NEW JERSEY: Trenton

NEW YORK: New York, Brooklyn, Buffalo, Rochester

OHIO: Cleveland, Cincinnati, Dayton, Toledo, Akron

OKLAHOMA: Oklahoma City

TENNESSEE: Memphis

TEXAS: Fort Worth, Dallas

WASHINGTON: Seattle

WISCONSIN: Milwaukee

Figure 13.- Public libraries containing nearly complete collections of NASA publications.

CALIFORNIA: Univ. of California Library, Berkeley

COLORADO: Univ. of Colorado Libraries, Boulder

DISTRICT OF COLUMBIA: Library of Congress

GEORGIA: Georgia Institute of Technology, Atlanta

ILLINOIS: The John Crerar Library, Chicago

MASSACHUSETTS: Mass. Instit. of Technology, Cambridge

MISSOURI: Linda Hall Library, Kansas City

NEW YORK: Columbia Univ., New York

PENNSYLVANIA: Carnegie Library of Pittsburgh

TEXAS: Southern Methodist University, Dallas

WASHINGTON: University of Washington Library, Seattle

Figure 14.- Special libraries for NASA technical documents and bibliographic tools.

NASA technical publications which are unclassified and unlimited in distribution may also be purchased by the general public from the Clearinghouse for Federal Scientific and Technical Information on an individual basis. Prices usually range between $1.00 and $4.00 per document. Anyone may also subscribe to STAR and IAA at a yearly cost of between $54.00 and $104.00 for each journal depending upon whether or not cumulative indexes are desired and whether mailing is domestic or foreign. Individual issues of STAR may be purchased for $2.24 per document. There is no charge for STAR to NASA personnel, contractors, or to many universities and public libraries.

From the dissemination activities described, it is evident that the efforts of the Scientific and Technical Information Division have not been constrained to exclude the nonaerospace community. As a result a system of technology transfer has evolved which benefits not only the aerospace industry but the civilian sector of the economy as well.

Trade Association Activities

As a further aid to the transfer of technology to potential users from the national space program, NASA actively supports various technical associations and professional societies that are part of the aerospace industry. This support consists of authorizing NASA employees and contractors to present talks at meetings, to author papers and journal articles, and to hold offices within the professional society whenever it is in the national interest to do so. In some cases, funding is also provided to professional societies by NASA contracts for services such as report translations, foreign literature surveys, and cataloging.

Many technical associations and professional societies exist in the various physical sciences, industry specialities, and professions. The largest professional society directly related to the aerospace industry is the AIAA (American Institute of Aeronautics and Astronautics). The other associations have similar activities to the AIAA, but on a much smaller scale. Since the nature of the various societies is identical, only the acitivities of the AIAA will be described to illustrate the part that trade association activities play in the overall technology transfer process.

Like most technical associations and professional societies, the AIAA is organized for the general purpose of improving communications between members employed by different Government and business organizations in various segments of the aerospace industry. To accomplish this purpose, various Technical Committees are established by the AIAA President to be responsible for the technical programs of the society. A listing of the 38 AIAA Technical Committees in figure 15 illustrates the large number of disciplines in which the society attempts to improve both communications and the technology transfer process. While the majority of the Technical Committees pertain to various segments of the aerospace industry; such disciplines as history, management, law, sociology, materials, thermophysics, and life sciences are included.

Meetings and conventions are sponsored by the various technical committees for the purpose of information interchange within the specific disciplines. Joint sponsorship of meetings with other professional societies often results in disciplines in which other technical associations and professional societies exist. The large

1. Aerodynamic Deceleration Systems
2. Air Breathing Propulsion
3. Aircraft Design
4. Aircraft Operations
5. Astrodynamics
6. Atmospheric Environment
7. Atmospheric Flight Mechanics
8. Communications Systems
9. Computer Systems
10. Electric Power Systems
11. Electric Propulsion
12. Entry Vehicles
13. Flight Testing
14. Fluid Dynamics
15. Ground Testing and Simulation
16. Guidance and Control
17. History
18. Launch Vehicles and Missiles
19. Law and Sociology
20. Life Sciences and Systems
21. Liquid Rockets
22. Management
23. Marine Systems
24. Materials
25. Nuclear Propulsion
26. Plasmadynamics
27. Propellants and Combustion
28. Sensor Systems
29. Solid Rockets
30. Space and Atmospheric Physics
31. Spacecraft
32. Structural Dynamics
33. Structures
34. Support Systems
35. Systems Effectiveness and Safety
36. Thermophysics
37. Underwater Propulsion
38. VTOL Aircraft Systems

Figure 15.- AIAA Technical Committees

number of disciplines with which the AIAA concerns itself means that each year a number of meetings and conventions are held. Figure 16 shows a schedule of AIAA meetings for a typical year. Not all technical committees sponsor a meeting every year. The large number of subjects covered by AIAA activities has caused membership to expand outside the aerospace community into virtually every major industry within the U.S. Attendees of the meetings come from the industrial field as well as the aerospace field because new technology and research is often an important indicator of future production requirements.

At AIAA meetings and conventions, members of the aerospace community, including NASA employees and contractors, give talks concerning new scientific technology and research. Written versions of unclassified talks are published as AIAA papers which are available to both members and nonmembers. In addition, the AIAA publishes various periodicals and journals containing new scientific information which are contributed by members of the aerospace industry. Figure 17 lists current AIAA publications. The AIAA is also active in the field of education. A journal is published giving results of research by students in various colleges and universities, and numerous short courses based on recent advances are sponsored in connection with AIAA meetings. Recently a program of home study courses based on tape cassette recordings of lectures has been initiated. It is also expected that university and industry libraries will purchase these tapes for use by students and industry personnel.

The activities of technical associations and professional societies enhance the technology transfer activities of NASA by

Feb. 10-12	AIAA Tactical Missile Systems Conference	Redstone Arsenal, Huntsville, Ala.
Feb. 10-14	AMS Symposium on Meteorological Observations and Instrumentation	Washington Hilton, Washington, D.C.
Feb. 17-19	AIAA/AMS/ATCA Research, Design, and Operations Meeting	Georgia Tech Atlanta, Ga.
March 3-5	AIAA 7th Electric Propulsion Conference	Williamsburg, Va.
March 10-12	AIAA 3rd Flight Test, Simulation and Support Conference	Marriott Motor Hotel, Houston, Texas
April 14-16	ASME/AIAA 10th Structures, Structural Dynamics, and Materials Conference	New Orleans, La.
April 16-17	AIAA Structural Dynamics and Aeroelasticity Specialist Conference	New Orleans, La.
April 21-25	Symposium on Astrodynamics and Related Planetary Sciences	Washington, D.C.
April 28-30	AIAA 4th Aerodynamic Testing Conference	Cincinnati, Ohio
April 30-May 2	AIAA Hypervelocity Impact Conference	Cincinnati, Ohio
May 20	AIAA Industry Enters into the Sea Conference	Seattle, Washington
May 21-23	AIAA 2nd Advanced Marine Vehicles and Propulsion Meeting and Technical Display	Seattle, Washington
June 9-13	AIAA 5th Propulsion Joint Specialist Conference	Colorado Springs, Colo.
June 16-21	4th Congress of the International Federation of Automatic Control (IFAC)	Warsaw, Poland
June 16-18	AIAA 2nd Fluid and Plasma Dynamics Conference	San Francisco, Calif.
June 16-18	AIAA 4th Thermophysics Conference	San Francisco, Calif
June 23-25	7th International Shock Tube Symposium	Toronto, Canada
July 2-3	CASI/AIAA Subsonic Aero- and Hydro-Dynamics Meeting	Ottawa, Canada
July 7-9	AIAA/SAE/ASME 8th Reliability and Maintainability Conference	Denver, Colo.
July 14-16	AIAA Aircraft Design and Operations Meeting	Los Angeles, Calif.
Aug. 5-7	Joint Automatic Control Conference	Boulder, Colo.
Aug. 18-20	AIAA Guidance, Control and Flight Mechanics Conference	Princeton, N.J.
Aug. 20-22	AIAA/AAS Astrodynamics Conference	Princeton, N.J.
Aug. 24-29	2nd Colloquium on Gasdynamics of Explosions and Reactive Systems	Moscow, USSR
Sept. 8-10	AIAA Aerospace Computer Systems Conference	International Hotel, Los Angeles, Calif.
Sept. 8-10	AIAA/ASTM/IES 4th Joint Space Simulation Conference	Los Angeles, Calif
Sept. 8-12	AIAA/RAeS/CASI 11th Anglo-American Aeronautical Conference	London, England
Sept. 21-24	4th Intersociety Energy Conversion Engineering Conference	Washington, D.C.
Oct. 9-10	17th Joint Engineering Management Conference	Montreal, Canada
Oct. 20-24	AIAA 6th Annual Meeting and Technical Display	Anaheim, Calif.
Dec. 1-3	AIAA Strategic Offensive/Defensive Missile Systems Meeting	Monterey, Calif.

Figure 16.- Typical AIAA convention schedule.

I. AIAA Papers - written versions of talks given at AIAA meetings.

II. AIAA Journal - articles concerning general research results and activities.

III. Journal of Aircraft - articles on research and developments concerning spacecraft and rockets.

IV. Journal of Spacecraft and Rockets - articles on research and developments concerning spacecraft and rockets.

V. Journal of Hydronautics - articles on research and developments concerning marine systems.

VI. AIAA Student Journal - articles on technical advances from student research.

VII. AIAA Selected Reprints - republication of articles on advancements of significant importance.

VIII. Astronautics and Aeronautics - AIAA magazine containing articles that review new research, program developments, and future trends in the fields of space flight, rocketry, and aeronautics.

Figure 17.- AIAA publications.

providing additional channels of distribution. Reports, journals, and other publications of the various societies are cataloged in the NASA Scientific and Technical Information Facility for announcement in STAR to potential users. Contracted services are provided such as the publication of the International Aerospace Abstracts (IAA) by the AIAA. Technical associations and professional societies provide an important communications link with the results of foreign research and development activities. Technical translation and publication activities by the various societies provide important new information to potential users in both the aerospace and industrial communities. Technical associations and professional societies are an important part of the total effort to transfer technology from the national space program to both the aerospace/defense and civilian industries.

Systems of the Future

Through a system of identification, recording and storage, and dissemination activities concerning technical publications, NASA has sought to provide users the large amount of scientific data being generated each day by the world's laboratories. During evolution of the present system, knowledge has been gained which will influence future technology transfer activities.[6] First, the information base must be broadened, either through the central collection or through rapid response communications networks linking related systems. Second, the information system of the future must be far more accessible to its users. The information system must become a desk-side utility like the telephone. Third, the system of the future

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[6]John F. Stearns.

must provide the information itself, not merely references to reports, books, or other files. It must become more like an encyclopedia and less like bibliography. These capabilities are years away but they are the goals toward which the world of scientific and technical information systems are moving.

IV. INFORMAL PUBLICATIONS AND SERVICES

Purpose and Scope of the Technology Utilization Program

Informal publications and services are part of the NASA Technology Utilization Program administered by the Technology Utilization Division. The major goal of the NASA Technology Utilization Program is to turn Government-generated technical innovations into national assets for many segments of our economic system. Transfer of new technology which does not enter into the formal report writing and distribution system as well as distribution of formal reports to the civilian economy is the mission of the program. Specifically, four purposes of NASA's Technology Utilization activities are:

(1) To increase the return on the national investment in aerospace research by encouraging additional use of results by non-NASA potential users.

(2) To shorten the time gap between discovery of new knowledge and its effective use in the market place.

(3) To aid the movement of new knowledge across industrial, disciplinary, and regional boundaries.

(4) To contribute to the development of better means of transferring knowledge from its points of origin to other points of potential use.

Laboratory mechanics, technicians, and instrument men produce many innovations and incremental advances which are worthy of note and

transfer to others but are not usually reported in scientific and technical articles, journals, or reports. Because of the long tradition of not formally reporting such shop- or production-orientated innovations, efforts at technology transfer in this area have been only moderately successful in the past. Charged with the obligation to provide for the widest practical and appropriate dissemination of information in the Space Act of 1958, NASA has become a leader in both developing and utilizing techniques of technology transfer. The program and its activities are still considered experimental in nature because new concepts are continually being tested and unsuccessful techniques being discarded.[1] As a result, the material contained herein must be considered as only a report of present status rather than that of either an inflexible or established process.

Activities of the Technology Utilization Program

Identification of Technical Innovations

Identification activities are considered the most important step in the technology transfer process.[2] New knowledge is brought into NASA by two major channels of communication. The first is the worldwide collection of formal documents by the NASA Scientific and Technical Information Division. This information is made available to the nonaerospace community through institutions supported by the

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[1] M. S. Day, "Management Overview," presented at a program review for NASA executives, February 1967 (Pamphlet).

[2] U.S., Congress, Senate, Subcommittee on Science and Technology of the Select Committee on Small Business, Statement by R. L. Lesher, Assistant Administrator for Technology Utilization, National Aeronautics and Space Administration, September 27, 1967.

Technology Utilization Division. The second channel for shop- or production-orientated technology is provided by the NASA field installations. At each installation, there are Technology Utilization Officers who work closely with the Technology Utilization Division in NASA Headquarters. The Technology Utilization Officers in the field have two fundamental duties. First, they are responsible for assuring that the professional personnel at their installations document and report the inventions, innovations, improvements, discoveries, and other forms of new knowledge developed at the installation. Second, the Technology Utilization Officers are responsible for administration of the New Technology Clause now included in NASA contracts for research and development. This clause obligates the contractor to report to NASA that new technology derived from work under the contract.[3]

To identify new technology from inhouse activities, all technical publications are reviewed by Technology Utilization Officers and other management officials prior to release. In addition, active programs are underway to encourage Government scientists and supervisors to be alert to new technology possibilities. Generally these efforts concerning research activities performed within the NASA installations have been quite successful.

Identification of new technology from contractor-performed research has not always been successful. It has been learned that passive efforts to administer the New Technology Clause will not result in active reporting. Active contract monitoring is required.

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[3]G. J. Howick, "Technology Utilization," presented at a program for NASA executives, February 1967. (Pamphlet).

Both motivation and education have been necessary. Setting of contractor performance standards, educating of contractor personnel to NASA requirements, insisting on contractor development of internal systems and procedures to identify new technology, and regular auditing of contractor performance have been required. The gradual conversion of contractor reporting efforts from a posture of passive administration to one of active acceptance has had a significant effect on the total volume of contractor-reported new technology. The present percentage mix of reports by place of origin (either inhouse or contractor) is beginning to approximate the same relative proportions as the allocations of NASA research and development expenditures.[4]

Evaluation of Technical Innovations

Following identification activities, new technical innovations must be evaluated for their suitability for transfer to the non-aerospace community. At NASA, the evaluation may take place at two levels, both at the NASA field installation and at independent research institutes under contract to NASA. Evaluation is always performed at the NASA field installation provided technical competence in the area of the innovation exists. In cases where the innovation is outside the area of technical capability of the field installation or disagreement exists on the suitability of the subject, the innovation is sent to an independent research institute for impartial evaluation.

At the field centers, the Technology Utilization Officers coordinate the evaluation process. Innovations by NASA contractors

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[4] Ibid.

are reported to him following procedures outlined in the New Technology Clause. In addition, inhouse research is reviewed for suitable innovations by several methods. Formal technical reports are reviewed for possible technology utilization applications as a part of the established editorial and publication process prior to distribution. All papers and talks given at technical meetings are surveyed for suitable material. Patent applications from inhouse research are reviewed for suitable concepts, and material from the installations suggestion programs are a source of many technical innovations. In addition, supervisors are strongly encouraged to look for and report possible innovations in their area of work. From these sources, the Technology Utilization Officers distribute evaluation forms to several "experts" in the technical area of the innovation at the field installations. In evaluating the innovations the questions of (1) does the innovation work, (2) how novel is the idea, and (3) what are the advantages and disadvantages of the concept are studied in detail. Following evaluation by field installation "experts," the results are reviewed by the Technology Utilization Officers. If approved for publication as a Tech Brief, no additional evaluation is required outside the field installations. If recommended as a Special Publication, Survey, etc.[5], then the material is forwarded to NASA Headquarters for evaluation. When the Technology Utilization Officers are undecided or the innovation is outside the technical competence of the field installations, the innovation is sent to an independent research center for evaluation. Here the material is

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[5]Tech Briefs, Surveys, etc., will be described in a following section.

reviewed by authorities in several areas and a computerized search of previously published literature is performed. Based on these studies, the innovation is either recommended or not recommended for announcement to the nonaerospace community by the independent research institute.[6]

Dissemination of Technical Innovations

After identification and evaluation, new technical innovations must be disseminated to the nonaerospace community. The backgrounds, area of interests, education levels, and geographic locations of the various recipients is quite varied. As a result, the dissemination activities of the NASA Technology Utilization Program are quite diverse. For purposes of clarity, the various publcations used for dissemination will be described first. Next the channels of distribution will be discussed followed by a review of other services offered by the Technology Utilization Program.

Publication medium.- New technical innovations are announced through the Technology Utilization Program through the variety of publications shown in figure 18. These publications differ in scope and information covered. The Tech Brief is the most popular Technology Utilization Program publication, and is a short, usually single-sheet bulletin describing an innovation and its basic principles in nontechnical language. Included in the Tech Briefs is an address from which the reader may obtain more detailed technical information concerning the innovation. Thus the Tech Brief is basically an announcement medium rather than a technical document. Tech Briefs are divided

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[6]John Samos, Technology Utilization Officer, NASA Langley Research Center, private interview, August 15, 1969.

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I. NASA Tech Brief - basic concepts & principles describing incremental advances

II. NASA Technology Utilization Compilations - similar to Tech Briefs but a collection of closely related incremental advances

III. NASA Technology Utilization Report - extensive description of innovation of special significance

IV. NASA Technology Survey - guidebook of latest advances in field authored by noted authority

V. NASA Technology Utilization Conference Proceedings

VI. Documentary Films

Figure 18.- Technology Utilization Program publications.

into nine categories, as follows, such that the reader may have to review only those innovations in his particular area of interest.

(1) Electronics

(2) Electronic systems

(3) Physical sciences (energy sources)

(4) Materials (chemistry)

(5) Life sciences

(6) Mechanics

(7) Machinery, equipment, and tools

(8) Fabrication technology

(9) Computer programs

Technology Utilization Compilations are similar to Tech Briefs but are a collection of incremental advances which are closely related in the state of a given art. The Technology Utilization Report describes innovations of special significance or complexity. More detailed technical information is included in this document than in Tech Briefs. Technology Utilization Surveys are used to consolidate efforts which have advanced whole areas of technology. Noted authorities write these "guidebooks" for NASA to help others benefit from the accomplishments described.[7]

Each year, NASA sponsors several conferences for particular industries and groups. An example of such conferences is one held at the Langley Research Center on May 22, 1969, on Aerospace Related Technology for Industry. This conference was co-sponsored by the

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[7]John Samos, "New Technology Documentation and Services Available Through the NASA Technology Utilization Program," paper given at a conference on Aerospace Related Technology for Industry, NASA Langley Research Center, May 22, 1969.

National Aeronautics and Space Administration, the Small Business Administration, the Virginia State Technical Services, and Old Dominion College. The purpose of the conference was to acquaint local industry representatives with the different kinds of new technology resulting from aerospace research and development programs and to explain how industry may gain access to that technology for profitable use. To document and disseminate new technology described at conferences such as this, Conference Proceedings are published as part of the Technology Utilization Program.

Some technical innovations are transferred to the nonaerospace community through the use of documentary films. Techniques or phenomena that are difficult to convey by written methods, or are subject matter that may be of interest to large groups are published by this medium. These films may be obtained on loan from NASA installations, and some may be purchased at the cost of reproduction.

In addition to the publications which describe new innovations, the Technology Utilization Program also publishes the Cumulative Index to Tech Briefs and an Index to Special Publications. Special Publications include the Technology Utilization Compilations, Technology Utilization Reports, Technology Utilization Surveys, and Conference Proceedings. Also available is a listing of documentary films that are available either on loan or for purchase.[8]

Distribution channels.- The major channel of distribution of new technical innovations from the Technology Utilization Program is

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[8] Ibid.

the use of subscriber mailing lists for Tech Briefs. Engineering- and marketing-type personnel, companies, magazines, periodicals, trade associations, professional associations, and state and local government agencies comprise the list of over 11,000 names who subscribe to either one or more categories of Tech Briefs on a yearly basis. Yearly costs presently range from $2.50 to $6.00 per category or $20.00 for all categories, and may be obtained from the Clearinghouse for Federal Scientific and Technical Information[9] with a minimum of effort. NASA Special Publications, the Cumulative Index to Tech Briefs, and the Index to Special Publications must be purchased from the Clearinghouse or the Government Printing Office.[10] Lists of the documentary films available for loan or purchase must be obtained from NASA installations. Mailing lists similar to those for the Tech Briefs are the principal announcement media for the special publications, indexes, and documentary films from the Technology Utilization Program.

Another important channel of distribution for Technology Utilization Program publications is the Regional Dissemination Centers. These Regional Dissemination Centers are operated by universities or independent research institutes at the various locations shown in figure 19 for the purpose of both transferring technology and educating industry in the use of externally-generated technology.

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[9]Clearinghouse for Federal Scientific and Technical Information, Attention: Code 410.14, Springfield, Virginia 22151.

[10]Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

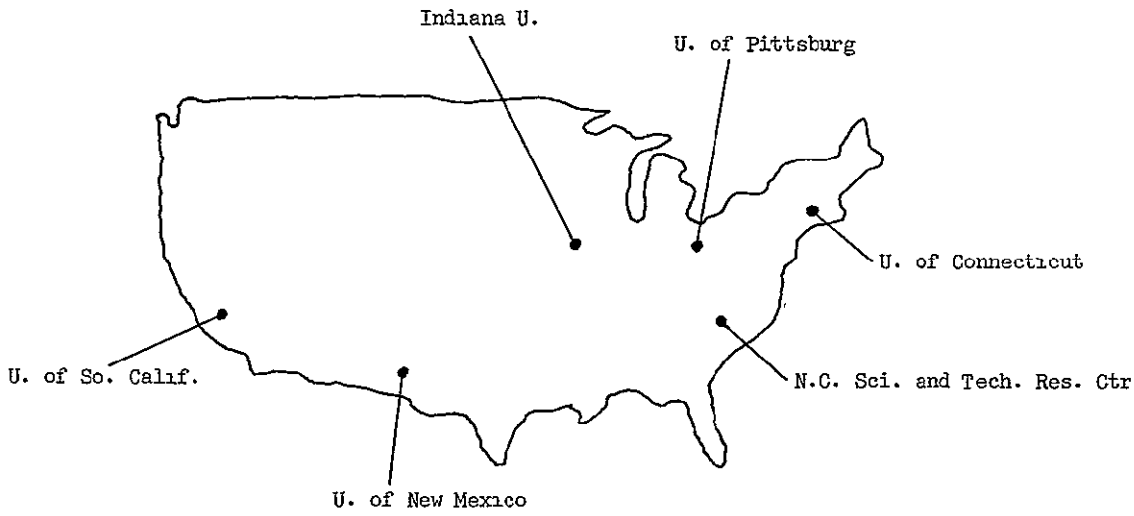

Figure 19.- Regional Dissemination Center locations.

Operation of these centers is designed for nonaerospace users. Tailored problem-solving and educational services are offered to both large and small companies through the variety of services illustrated in figure 20. To inform clients of new innovations and technology advances as they become available, Current Awareness Searches and Standard Interest Profiles are performed. On a monthly basis, updated computer tapes from the Scientific and Technical Information Facility are scanned for both formal technical reports and Technology Utilization publications in the subject area of interest to the client. Additional information may then be obtained through the distribution function of each center. In the event that a company has a specific problem, a Retrospective Search of the computer tapes and other sources may be performed for the client in an effort to determine what is available in both formal technical reports and Technology Utilization publications. The centers actually provide the documents located by the search when requested to do so by the client company. Such a service is possible because of the microfiche cataloging system of the Scientific and Technical Information Facility. Finally the Regional Dissemination Centers offer educational assistance to management in terms of organization for the collection and use of externally generated technology. Through the various services available, the Regional Dissemination Centers offer nonaerospace industrial users access to the world's aerospace technical reports and scientific articles as well as shop- or production-orientated technology innovations derived by the Government or at Government expense by contractors.

I. Current Awareness Searches - computer tapes searched monthly for information of possible value to clients.

II. Standard Interest Profiles - lower cost Current Awareness Searches based on standard fields of interest.

III. Retrospective Searches - response to technical questions by member companies.

IV. Publications Distribution - technology utilization publications and provide fuller information on requested subjects.

V. Assistance to Management - aid to systematizing collection of data and use.

Figure 20.- Regional Dissemination Center services.

Each Regional Dissemination Center is initiated with NASA's financial support. After a period of time, each center is expected to become self-supporting through fees earned from industry clients. The client companies pay fees for the various services on a scale commensurate with the companies size and the extent of the services desired. Fees also vary with each Regional Dissemination Center because of its geographic location and specific economic environment. Yearly fees may run several thousand dollars for large companies utilizing all services available. In terms of the research and development information available, however, the cost may be quite inexpensive when viewed in terms of the total research and development budget. Thus far, the services of the Regional Dissemination Centers have proved useful to companies in (1) creating new products, (2) improving production processes, (3) establishing research and development priorities, (4) avoiding duplication of research already done elsewhere, and (5) improving managerial practices.[11]

Services for the civilian industry.- In addition to the distribution of publications through the use of mailing lists and Regional Dissemination Centers, aerospace technology is transferred to the civilian economy through a variety of other services and activities under the direction of the Technology Utilization Program. Many of these activities are only small experimental programs at the present time. In an effort to indicate the variety of services available, several of the more important activities which have become a part of the Technology Utilization Program are summarized in the

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[11]Leon Shloss, "Space Makes Haste: NASA Rushes Space Spin-Off to the Public," Government Executive, (July 1969), pp. 77-81.

following paragraphs. In particular, the activities related to the transfer of NASA-derived computer programs, aid in the field of medical research, creation of education enrichment materials, and cooperative programs with other agencies are described.

NASA has invested millions of dollars in the development of computer programs. To enable nonaerospace users to benefit from this investment, the Computer Software and Management Information Center (COSMIC) has been established at the University of Georgia under contract to NASA. This Center collects, evaluates, and distributes tapes, card decks, program listings, and machine-run instructions. This "Software" is available to potential users from both COSMIC and the Regional Dissemination Centers at prices determined by the cost of reproduction and distribution. A computer program that originally cost up to $100,000 to develop may be purchased by a company for less than $300.[12] Recently an important milestone was passed when the Department of Defense joined NASA and agreed that computer software developed for defense use will also be available to industry through COSMIC. While sophisticated computer programs describing reentry motions or orbital mechanics are of little use to the civilian economy, those utilized to manage massive projects or to describe detailed chemical or other scientific processes are quite valuable to the nonaerospace user. Items available through COSMIC are announced through a journal entitled Computer Program Abstracts which is available quarterly and on a subscription basis from the Superintendent of Documents.[13]

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[12]Samos, "New Technology Documentation ..."

[13]Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

To aid in medical research, NASA has formed Biomedical Application Teams at the Midwest Research Institute,[14] the Southwest Research Institute,[15] and the Research Triangle Institute.[16] Each team consists of representatives of both the aerospace and medical professional communities formed with the purpose of identifying and defining barriers which impede medical progress. Their functions are as follows:

(1) Selecting and specifying biomedical problems to which NASA-generated technology may be applicable.

(2) Searching for potential aids in solving these explicit problems in aerospace centers, libraries, laboratories, and plants.

(3) Facilitating biomedical workers evaluation of potentially helpful suggestions and equipment.

(4) Documentation of these transfers of science and technology so as to achieve maximum utilization of the results.

The activity is organized under the NASA Technology Utilization Division as shown in figure 21. Biomedical Research Groups define medical problem areas for the Biomedical Application Teams. The teams then organize the search of computer tapes from the Scientific and Technical Information Facility and solicit guidance and suggestions from aerospace scientists at the various NASA field installations. After results of the search are evaluated by the

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[14] Midwest Research Institute, 425 Volker Boulevard, Kansas City, Mo. 64110.

[15] Southwest Research Institute, 8500 Culebra Road, San Antonio, Texas 78206.

[16] Research Triangle Institute, Post Office Box 12194, Durham, N.C. 27709.

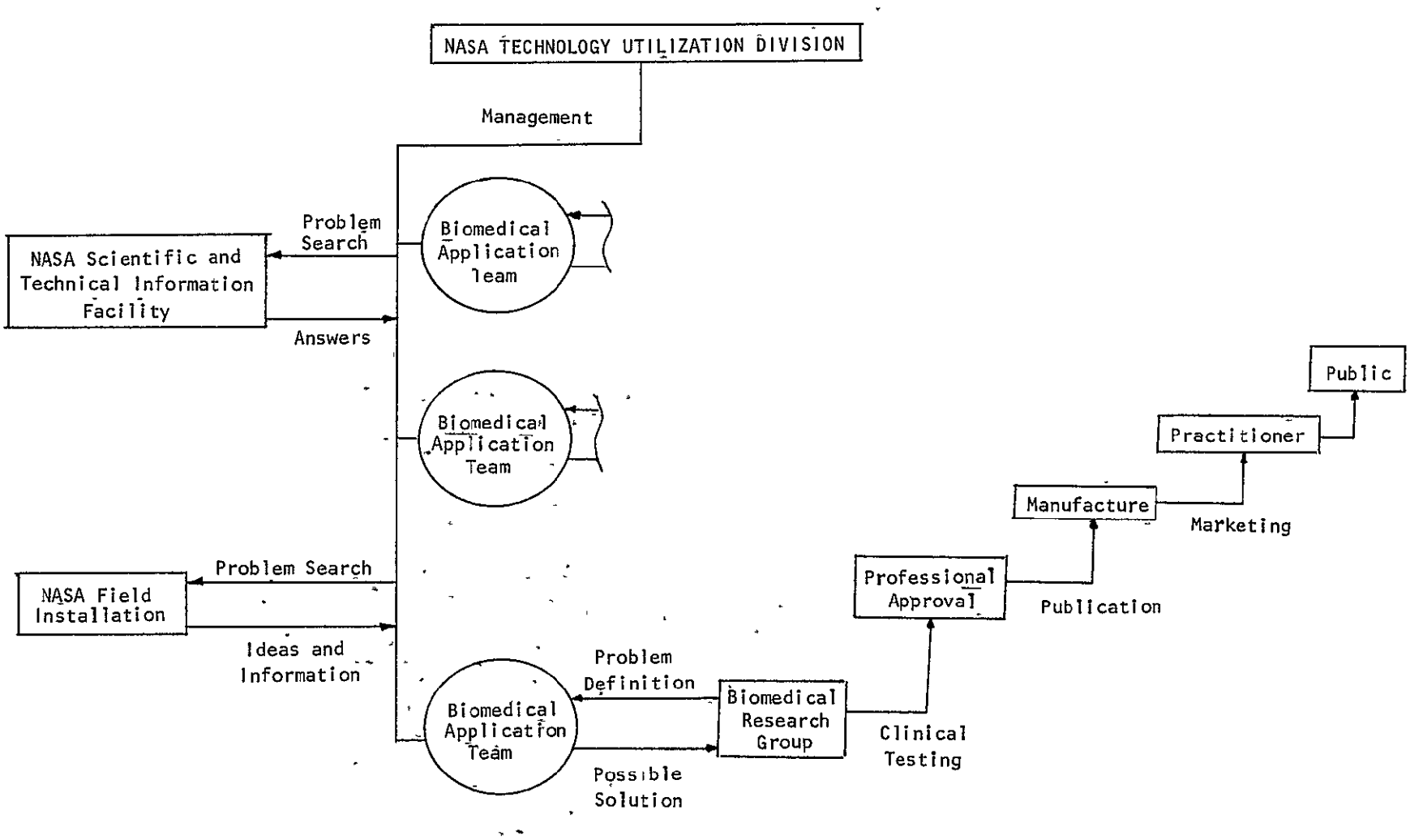

Figure 21.- Organization of Biomedical Application Teams.

Biomedical Application Teams, possible solutions are forwarded to the Biomedical Research Group which defined the problem. If the solution proves successful after clinical testing, it eventually reaches the public through the normal evaluation process of the medical profession. Throughout the evaluation process, records are maintained on the progress of each problem and possible solution. Figure 22 is a typical status report on one medical problem which is currently active.

As an aid to the field of education, the Technology Utilization Program is testing methods of accelerating the transfer of technical knowledge from the aerospace industry to engineering curricula of colleges and universities. Oklahoma State University, under contract to NASA, prepares instructional monographs from source material from NASA research and development reports. These texts are written in an educational format for use on a trial basis as supplementary teaching aids in classroom situations. Over 100 universities have reviewed and used these monographs, and have provided positive evaluation reports to NASA. Reports from practicing engineers in industry reveal that the same educational monographs have utility and value as a teaching aid in continuing education programs carried out by companies they represent. Further development of the concept is being considered as a means for improving the quality of formal engineering education.[17]

NASA has numerous cooperative programs to help other Government agencies benefit from its research and development efforts. The

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[17] Useful New Technology From Aerospace Research and Development, Washington, D.C.: NASA Headquarters, 1969, p. 11 (Pamphlet).

Implantable Pressure Sensor and Telemetry Unit for Measurement of Fluid Pressure in the Cranial Cavity

Dr. D. L. Kelly, Jr., Bowman Gray School of Medicine
Wake Forest University

Description of Problem and Solution:

A researcher in the Department of Neurosurgery at Bowman Gray is engaged in research activities associated with the build-up of fluid pressure in the cranial cavity. Many people have a fluid build-up that occurs in the cranial cavity, and this pressure must be relieved. This is usually accomplished by inserting a pickup tube inside the cranial cavity and running a piece of tubing down underneath the skin in the rear of the head, finally discharging the fluid into one of the blood vessels where the fluid is dispersed. A special one-way valve known as a Holter valve is used to prevent passage of blood into the cranial cavity. Not infrequently, this valve will stick closed, and pressure will begin to build up in the cranial cavity of the individual. Monitoring of the pressure in the cranial cavity must be accomplished by means of a small pressure transducer and then telemetered outside the body for pick up. The Ames Research Center implantable pressure biotelemetry system seems feasible for this application, if the operating life of the transmitters can be extended sufficiently.

Successful Searching Method:

Information on the Ames pressure biotelemetry system was already available to the Biomedical Application Team at the time this problem was proposed. The information on the Ames biotelemetry system originally resulted from NASA Tech Briefs on the subject and visits to the Ames Research Center.

Source of Solution:

Ames Research Center

Benefits to be Derived from Transfer:

The required instrumentation and telemetry system would permit the gathering of data which is not now available on pressure buildup in the cranial cavity.

Current Status:

The Research Triangle Institute is currently preparing a cost estimate on fabrication of a biotelemetry system modeled after the Ames units using discrete components. This information will be used by the researcher to establish feasibility for his particular application. In addition, specifications and information on long-term telemetry are also being gathered for his evaluation.

Prognosis for Actual Transfer:

Incomplete.

Figure 22.- Example of active problem defined by Biomedical Application Team.

technology generated by one agency is often found to be useful to another agency concerned with an utterly different facet of the nation's welfare. These joint programs are expanding the channels for technology transfer into such activities as law enforcement, mine safety, assistance to small business, rehabilitation of handicapped persons, regional economic development, transportation, and air and water pollution. The interest areas which are of concern and in which NASA can make potential technological contributions include: management and technical information systems; weather modification; highway safety; and many specific fields of medicine and biomedical technology. Personnel are sometimes loaned from the NASA Technology Utilization Division to other agencies for aid in technology identification and problem solving activities.

One cooperative program of particular interest is the agreement with the Small Business Administration. The purpose of the program is to encourage the use of new technology by the smaller companies. The Small Business Administration has established its own technology utilization program which publishes a series of documents called Tech Aids. These publications describe new technical advances applicable to the small business. NASA Tech Briefs and Special Publications are extensively used as sources for Tech Aids. The purpose of the Tech Aids is to keep small business firms informed of research and development performed in other agencies. Such information is used to point out both opportunities and threats to markets as a result of technology advancement.[18] In today's rapidly changing

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[18] L. Parker Fairlamb, "Services Performed by the Small Business Administration," Paper given at a Conference on Aerospace Related Technology for Industry. NASA Langley Research Center, May 22, 1969.

world, the need to act in response to pressures that the technology explosion is exerting is urgent. Thirty years from now the environment will be vastly different and changes will have to come from the development and application of today's technology.

To further aid in the transfer of aerospace technology to the local businessman, NASA cooperates with state governments under the Federal State Technical Services Act of 1965. This act, administered through the Department of Commerce, is intended to provide for economic growth of the Nation. The program is supported jointly by both Federal and State funding and there is no charge to clients for services. The purposes of the State Technical Services are to effect wider distribution and application of science and technology, to promote commerce and economic growth, reduce the time lag between discovery and application, and to assit the state's businessmen through educational programs. To provide these services, each state has appointed Field Service Representatives with diverse backgrounds and experience that are affiliated with various institutions of higher learning throughout the state. The Field Service Representatives provide the functions and coordination between various groups shown in figure 23. Upon request for problem solution from industry, business, or commerce organizations; the Field Service Representatives draw on Government agencies, educational institutions, industry contacts, and consultants for advice and analysis of the situation. Proprietary functions are not revealed to anyone by the Field Service Representative. The Field Service Representatives prefer not to deal with technical problems in a proprietary system or process whenever possible. Besides solving existing problems,

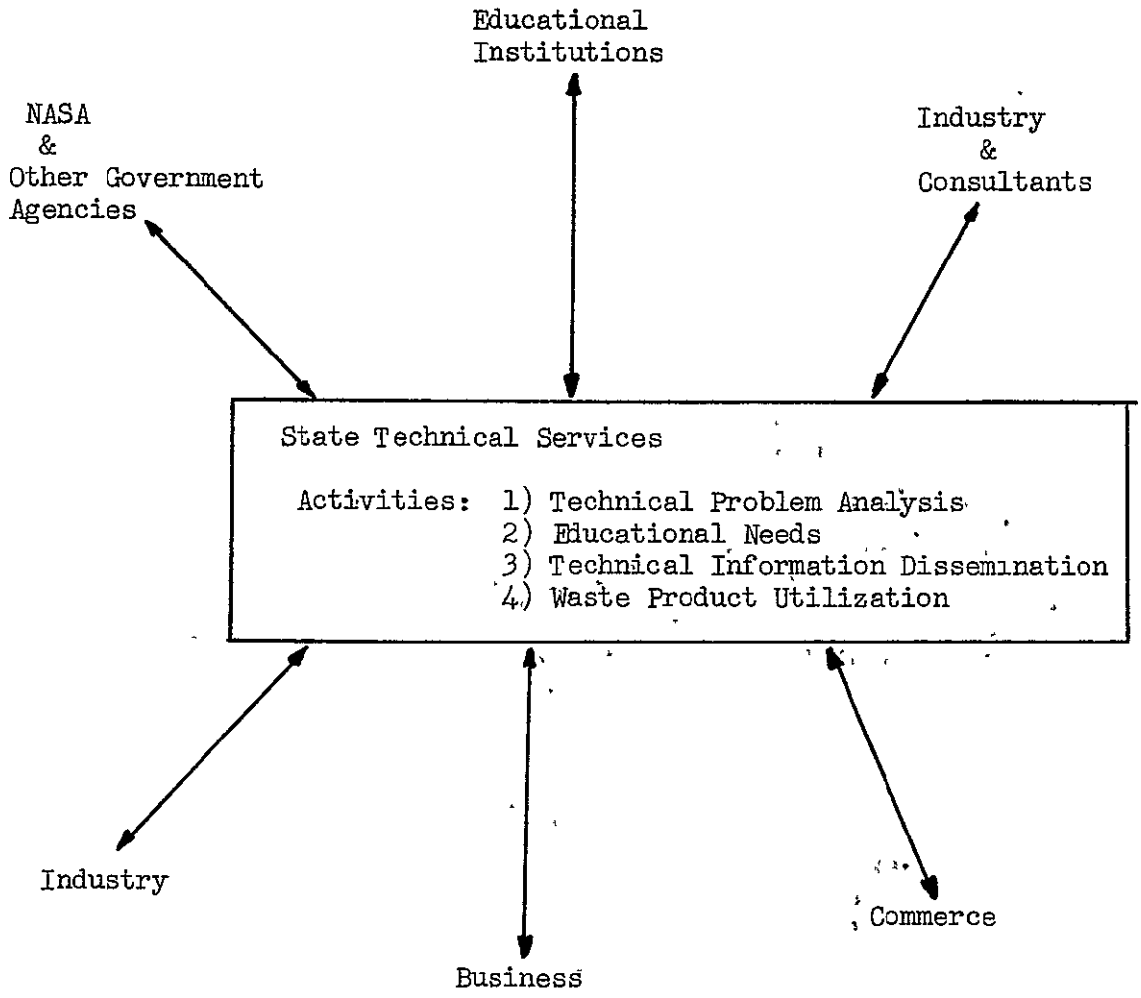

Figure 23.- Functions of State Technical Services.

the State Technical Services desire to promote new business, in particular the generation of new uses for waste products. Technology innovations are continaully reviewed for possible application of waste products generated within the particular state or location by the Field Service Representatives.

Publicity Activities

NASA Policy

Technical innovations are announced to the general public through Public Affairs activities. All publicity activities of NASA are handled through the Office of Public Affairs. The Office of Technology Utilization has a separate Public Affairs Officer assigned to it from the Office of Public Affairs. Functionally, the Public Affairs Officer of the Office of Technology Utilization coordinates and releases all information through the Office of Public Affairs.[19]

NASA public affairs activities are based on a policy of "soft-sell" which relies primarily on the professional ability of the individuals within the organization.[20,21] Information is released to the newspaper, radio, and television media, but no advertisements or purchase of broadcast time is authorized. NASA attempts to cooperate fully with the news media when specific requests for information are made, however. Requests from the news media and

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[19]Mary Fitzpatrick, Public Affairs Officer, Office of Technology Utilization, NASA Headquarters, private interview, January 27, 1970.

[20]Ibid.

[21]Daniel Wentz II, Associate Head, Office of Public Affairs, Langley Research Center, private interview, January 22, 1970.

students are handled by local Public Affairs Officers at the various facilities in coordination with the Office of Public Affairs in NASA Headquarters. Advertising copy of NASA contractors must receive clearnace from NASA Headquarters if NASA-sponsored activities are tied in with commercial products or NASA photos are used. NASA attempts to accommodate contractors whenever possible providing advertising is (1) at no expense of the Government, (2) on a non-interference basis, and (3) on a nonhazardous basis. Generally use of NASA facilities by non-Government contractors is not approved to eliminate the possibility of agency activities becoming part of a "commercial circus." NASA willingly supplies film and other educational material for use by either contractors or commercial groups for public purposes such as civic association meetings.

Types of Material Released and Distribution Media

Ideally, notice of all new technical innovations is released to the news media for dissemination to the general public. In practice, only a fraction of the technical innovations from the space program are the subject of news releases.[22] The reason being that the majority of technical innovations appeal to only small industrial groups and, as such, make rather drab news releases. The final decision to publicize a news release from NASA lies with the managers of broadcast stations and newspaper publishers. Experience has shown that drab news releases without dramatic effect or sex appeal seldom are publicized by individual broadcast stations or newspapers. For this reason, only those technical innovations which

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[22]Mary Fitzpatrick.

can be made into a "good story" are released to the news media by NASA. Individual innovations relating to the fields of medicine or safety are usually released for consumption by the general public.

News releases from NASA are mailed to over 500 newspapers and magazines and to several hundred radio and television stations. The combined circulation and broadcast area of these media include over eighty percent of the population of the United States.[23] In spite of this wide circulation, many of the news releases describing technical innovations do not get fully publicized if there is more dramatic news to fill the newscast or newspaper that day. As a result, the general public is provided little information on the side-dividends of the space program. Advertisements by Government contractors showing commercial products based on NASA research appear to be a major channel of distribution for publicizing technical innovations. Since all advertisement of this type must have prior approval from NASA, only limited advertising copy of this type is published outside of trade journals. The "soft-sell" policy of NASA and the journalistic approach of providing dramatic effect combine to hide from the general public one of the major benefits of the space program, technology spin-off through the technology transfer activities of NASA.

Direction for the Future

The NASA Technology Utilization Program began in the experimental stage. It was realized that each activity would initiate as an experiment, and analysis would be required to determine whether

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[23] Ibid.

or not the activity should be continued or terminated. A strong analysis function was built into the program from the beginning based on the objective that the program remain flexible. Detailed records were kept, and each activity has been evaluated within NASA in accordance to the "marketplace" test. That is, user response and activity growth have been carefully monitored to eliminate those processes to which the nonaerospace user did not respond. For example, it was quickly realized that the Technology Utilization Program publications were successful as their rate doubled in three years. Mailing lists were revised when analysis showed that 70 percent of all inquiries received by Technology Utilization Officers was the result of business press mention of innovations in Tech Briefs. The Regional Dissemination Center concept was termed successful when it became evident that both small and large companies utilized the services, and 90 percent of the subscribers continued as the total yearly subscription number nearly doubled. COSMIC was quickly a success as 3,523 inquiries for additional information were answered and 288 card decks and tapes were sold during the first 5 months of operation with only 148 programs in inventory. The list of successful transfers through the use of the Biomedical Application Teams is growing steadily, and reviews of the educational monographs have been so good that NASA is planning on sharing the sponsorship of the program with other agencies. Not all activities have been successful, however. Two of the initial seven Regional Dissemination Centers were dropped and one was added to achieve today's organization, for example. The true test of the Technology Utilization Program cannot yet be made. The real worth lies in whether it can change

the habits of scientists, engineers, and managers. Creative men must be spurred to document and communicate their knowledge for the use of others and those "others" must seek out and employ relevant new knowledge generated elsewhere.[24]

To aid in design of the system of the future, the Denver Research Institute,[25] under contract to NASA, is studying current functional processes used in the Technology Utilization Program. This collection of data on technology transfer will provide additional feedback for analysis of both current and future activities. In addition, the Denver Research Institute is in the process of establishing a library relevant to the technology transfer and utlization process. This should be of considerable value to future researchers interested in investigation of the technology transfer process.

The Technology Utilization Program has progressed in several respects. First, the body of documented scientific and technological knowledge is growing very rapidly. Second, many improvements in processing have been made, and others are planned. Number three, many of the experiments have already proven their value, and others are on the way. Finally, fourth, there is a large, growing and attentive user audience.

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[24] G. J. Howick.

[25] Denver Research Institute, University of Denver, Denver, Colo. 80210.

In connection with these advances, much knowledge has been gained. Requirements for future systems have been summarized as follows:[26]

(1) The most important step in the transfer process is the identification activity. Technology exists in many forms in both documents and the minds of men.

(2) A programatic approach to the transfer process is required. The system must be responsive to varying needs, provide services, be flexible, incorporate processing and screening functions to add value, provide a measure of utility and a feedback mechanism, and provide a means of exchanging services.

(3) A large committment on the part of the responsible agency is required.

(4) The closest kind of cooperation among agencies is required for success.

(5) Especially skilled people are required as transfer agents.

(6) The traditional "trusted source" institutions must be used to provide transfer services to industry. Universities and nonprofit research institutes must bridge gap between the information base and the user.

(7) The responsible agency must assume an entrepreneurial attitude to enlarge the return on the national investment in research and development.

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[26]U.S., Congress, Senate, Subcommittee on Science and Technology of the Select Committee on Small Business, Statement of Richard L. Lesher, Assistant Administrator for Technology Utilization, National Aeronautics and Space Administration, September 27, 1967.

(8) It is important to provide screened information whenever possible to encourage use.

(9) It is important to deliberately design mechanisms and processes to couple research and development information together and to gather packages from a variety of sources.

From these requirements, it is evident that the successful Technology Utilization Program of the future is neither insignificant nor inexpensive in terms of manpower and dollar costs. These expenditures will be repaid many times in terms of economic growth, however.

V. PATENT LICENSES AND WAIVERS

NASA's patents and license regulations are a further aid to the transfer of technology. They encourage industrial use of inventions that result from research and development work performed by employees of NASA and its contractors. All new technology and inventions derived from work under a NASA contract must be disclosed promptly to NASA and become the agency's exclusive property. NASA may waive all or any part of the rights to an invention to the contractor, however, if it is in the public interest to do so. The waiver of rights to contractors is described in some detail in a following section.

To encourage the earliest possible commercial use, all inventions on which rights are not waived to the contractor and for which either a patent application has been filed or a patent is held are available to American firms or private citizens for royalty-free license from NASA. A few inventions are also available for licensing by foreign firms. The licensing of NASA-owned inventions is also described in more detail in a following section.

Licenses to Industry

Policy of NASA

It is considered that NASA inventions (inventions for which the Administrator, NASA, holds a U.S. patent) will best serve the interests of the United States when they are licensed and developed

to the point of commercial utility. Although the nonexclusive licensing of NASA inventions is generally preferable, the granting of an exclusive license is considered desirable when an additional incentive appears necessary. In selecting an exclusive licensee, consideration is given to providing assistance to small business and labor surplus areas. No royalties are charged by the National Aeronautics and Space Administration for the making, use, or selling of any embodiment of an invention. A list of NASA inventions available for licensing is published in the Official Gazette of the United States Patent Office. It is required that this list be revised quarterly to include all NASA inventions currently available for licensing.

Types of Licenses

Three types of licenses are available from NASA. These types are (1) a nonexclusive, revocable license for inventions not yet developed to the point of commercial utility, (2) a nonexclusive license for the term of patent for inventions which have been developed to the point of commercial utility, and (3) an exclusive license. Conditions and procedures for each type of license are described in the following paragraphs.

For inventions not yet developed to the point of commercial utility, NASA will grant a nonexclusive license to make, use, or sell any embodiment of the invention for the first two years after the issuance of the U.S. patent. The license is revocable if the licensee fails before the end of the second year to demonstrate that the invention has been developed to the point of commercial utility.

After development to the point of commercial utility, the nonexclusive license may be extended for the life of the patent or converted to an exclusive license.

For inventions developed to the point of commercial utility, NASA reserves the right to dedicate to the public the invention provided it has been patented two years and is not subject to an outstanding exclusive license. A nonexclusive license to make, use, or sell any embodiment of the invention is granted upon an applicant showing that the invention has been developed to commercial utility provided the invention has not been dedicated to the public or is subject to an exclusive license. Similar nonexclusive licenses will be granted to any qualified applicant.

Each NASA invention which has not been developed to the point of commercial utility by the end of the second year after U.S. patent issuance is made available for the grant of an exclusive license. An exclusive license is not granted until after three months from the date on which the invention has been listed as available for exclusive licensing. This time increment is in order to provide a suitable time interval for all interested applicants to submit their applications. Preference is given to adequately qualified applicants in labor surplus areas and to small business concerns. The term of an exclusive license is negotiated. A nontransferable, royalty-free right to practice the invention by or on behalf of the United States is reserved. The exclusive license is also revocable if the licensee fails to use his continuing best efforts to develop the invention.[1]

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[1]U.S., Federal Register, Vol. XXXI, No. 104 (May 28, 1966), Title 14, Ch. V, Pt. 1245, "Patents," pp. 7677-7679.

Provisions and Clauses

All licenses granted to industry by NASA contain certain clauses for the protection of the public. No member of Congress may be admitted to any part or benefit of a license unless the license is granted to a corporation for its general benefit. The license may be annulled for violation of a contingent fees clause to protect against hidden fees. NASA makes no warranty that the practice of the invention will be free from infringement of any other patents and assumes no liability that may result from the exercise of a license. All disputes concerning the interpretation or application of a license agreement which are not settled by mutual agreement are decided by the officer executing the license on behalf of the Government. Licenses for undeveloped inventions carry a revocation clause based on the two-year time limit described earlier, and exclusive licenses carry a reporting clause, a sublicense clause, as well as the revocation clause based on continued effort. For exclusive licenses, the licensee has the right to sue at his own expense any infringers of the patent. If the patent is declared invalid, the licensee may surrender his license and is relieved of any further obligation.

Waivers to Contractors

Policy and Procedures

Waiver of rights to contractors for NASA-financed inventions has the objectives of (1) providing incentives to foster inventiveness

and to encourage reporting of inventions made under NASA contract, (2) providing for the widest practicable dissemination of new technology, and (3) encouraging the expeditious development and adoption of this new technology for commercial purposes.[2] Waiver of title to an individual invention may be requested at three times during the life of a contract. The request may be made (1) at the time of contracting, (2) within sixty days after execution of the contract, and (3) after reporting of the invention. Waiver may be requested at any of these times even though a request was made and not granted at an earlier date.

Requests for waiver made either at the time of contracting or within sixty days after execution of the contract will normally be granted if the NASA Inventions and Contributions Board makes each of the six following findings concerning the request:

(1) It is not a principal purpose of the contract to create, develop, or improve products, processes, or methods which are intended for commercial use.

(2) It is not a principal purpose of the contract to explore into fields which directly concern the public health or welfare.

(3) The contract is not in a field of science or technology in which there has been little significant experience outside of work funded by the Government.

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[2] Ibid.

(4) The contract is not for services of the contractor for (i) the operation of a Government-owned research or production facility or (ii) coordinating and directing the work of others.

(5) The purpose of the contract is to build upon existing knowledge of technology for use by the Government.

(6) The work called for by the contract is in a field of technology in which the contractor has acquired technical competence.

A waiver granted based on these findings shall be effective only with respect to inventions which are reported during the term of the contract under which they are made and designated at the time of reporting as being inventions upon which the contractor intends to file or has filed a U.S. Patent Application.[3]

Requests for waiver made after an invention has been reported to NASA will normally be granted if the NASA Inventions and Contributions Board finds that waiver of title to the contractor would be an effective incentive to bring the invention to the point of practical application at the earliest practicable date. Such a ruling is made after investigation of the contractor's plans and intentions. Request for waiver will not be granted when it is found that one or more of the following is true:

(1) The invention is directly related to a Government program for use by the general public.

(2) The invention will be required by Government regulation for use by the general public.

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[3] Ibid.

(3) The invention is directly related to the public health or welfare.

(4) The invention is in a field of science or technology in which there has been little significant experience outside of work funded by the Government.

Reservations and Conditions

All waivers to title granted contractors are subject to certain reservations and conditions. All waivers are subject to the reservation that the Government may obtain an irrevocable, nonexclusive, nontransferable, royalty-free license for practice of the invention throughout the world by or on behalf of the United States or any agency thereof. In addition, a license on a non-exclusive, royalty-free basis may be granted to any applicant unless:

(1) The contractor or his licensee has brought the invention to the point of practical application within three years after issue of a U.S. patent.

(2) Such patent has been made available for nonexclusive licensing to any responsible applicant either royalty-free or on reasonable terms within three years after patent issue.

(3) The contractor shows cause why he should retain the full benefits of the waiver for a further period of time.

NASA may require granting of a license to any responsible applicant either royalty-free or on reasonable terms for practice of the invention to satisfy either requirements made by Government regulation for public use or as may be necessary to fulfill health

needs. The holder of the waiver is always given the opportunity to show the NASA Inventions and Contributions Board cause why he should not be required to grant such a license.

In addition to the above reservations, each waiver is voidable at the option of NASA unless:

(1) Within eight months after reporting an invention subject to a waiver, the contractor files an application for U.S. patent specifying that the invention was under NASA contract.

(2) The contractor furnishes to NASA a copy of each patent application.

(3) The contractor executes and furnishes to NASA instruments fully confirmatory of the rights reserved by the Government.

(4) The contractor notifies NASA in the event he elects not to continue prosecution of any patent application within sufficient time for assumption of prosecution by the Government.

(5) The contractor conveys to NASA his entire right, title, and interest in any foreign country in which he has not filed a patent application within certain time limits.

(6) The contractor grants any license which NASA may require to be granted pursuant to previously described reservations.

(7) The contractor reports, upon NASA's request, the commercial use that is being or is intended to be made of the invention.

In addition, all waivers to title are voidable if the patent disclosing and claiming of an invention is held to have been used in violation of antitrust laws.[4]

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[4] Ibid.

The waiver of title to contractors is a powerful tool for the transfer of aerospace technology to other sectors of the economy. The reservations and conditions of such waivers are such that the Government may retain control of the invention and limit abuse to the system. A contractor who receives a waiver on an invention must be prepared for constant review of progress by the Government and must instigate a number of procedures in connection with processing the invention.

Suitability of Patent Policy

The suitability of Government patent policy as a mechanism for the transfer of technology to the civilian economy is a highly controversial issue. In the late fifties and early sixties, charges and countercharges bristled the air. In the last few years, the noise seems to have died out which may be the result of a concentrated effort to study in greater detail the principles of Government patent policy. In 1965, a Committee on Government Patent Policy made up of members from all federal agencies was established. After review of various answers to policy issues offered by the literature and in testimony in Congress, the Committee felt that most of these answers were based on opinion on the part of Government and industry representatives and that little had been done to accumulate facts and data on the subject. To fill this information gap, the Committee contracted with Harbridge House to accumulate the data necessary to informative answers to the questions on the effect of Government patent policy on utilization, participation, and completion.[5] The

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[5]Leonard Rawicz, "An Appraisal of the Harbridge House Study From the Research and Development Agency Viewpoint," Presented to Briefing on Patent Law, September 26, 1969.

results of this study as applicable to NASA patent policy are discussed in the following paragraphs.

The Harbridge House study is viewed by some authorities with criticism and skepticism, mainly because of the limited amount of statistics which could be collected and their use. Notwithstanding the criticism voiced, most people view the study as a valuable addition to the patent literature. Many of the results of that study concern items which are part of NASA patent policy and concern suitability of present patent policy as a technology-transfer mechanism.

The Harbridge House study disagrees with the single presumption theory, the all white or all black position, that either the Government should have title to all inventions made under sponsorship of an agency, or that all the Government ever needs is a license to practice the inventions, with no title to any. The study concludes that operational flexibility in the allocation of rights to inventions is needed for Government agencies to accomplish their missions under different contract situations. NASA's policy and procedures with respect to both waivers to contractors and licenses to industry contain this type of flexibility. The study backs the basic soundness of a policy which permits decision on the allocation of rights at time of contracting in some situations, and at a later time after the invention has been identified in other cases. Normal acquisition of title by the Government whenever the purpose of the contract was public oriented is also supported. The study indicates that exclusive rights in the contractor are generally not necessary in order to achieve the desired commercial utilization whenever (1) there is a

waiting market for the results of the research, (2) the results of the research are developed to completion in a technical and commercial feasibility context, and (3) the research is followed up with promotional and marketing activity by the Government agency. The Harbridge House study also adequately presents a case for the grant of "greater rights" to the contractor on a case by case basis after the invention has been identified. Patent policy should be flexible enough to provide for a balancing of the interests of all parties where the grant of "greater rights" is a necessary incentive to call forth private risk capital. NASA procedures allow the granting of exclusive licenses and waivers to provide such an incentive in certain cases. A statistical correlation between increased commercial use and contractors having both prior commercial experience and exclusive rights is also shown. There is expressed doubt to the statistical validity of this particular set of data, however.[6] The study does reach the conclusion that permitting contractors to retain exclusive rights in inventions stemming from mission-oriented research and development contracts does not have an adverse effect on competition for two basic reasons. The first is that the rate of use of these inventions is low, and the second is that contractors are generally willing to license these inventions. The study also finds that exclusive rights may tend to promote utilization when the invention is not directly applicable to commercial uses and requires private development to perfect it,

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[6] Ibid.

applies to a small market, or is in a field occupied by patent-sensitive firms.[7]

While the Harbridge House study is not without criticism, it does represent a valid attempt to collect pertinent data. The fact that NASA policies contain much of the flexibility advocated by Harbridge House is at least one piece of evidence that patent opportunities are an effective mechanism for technology transfer.

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[7] Ibid.

PART III

SUMMATION

VI. THE TECHNOLOGY TRANSFER PROGRAM

Recapitulation

The effective technology transfer program must combine the principles of communications, promotion, and distribution into an integrated activity which is both available and economically feasible for prospective users. The precise nature of the successful technology transfer process is complex and still not completely understood. Hence, the activities of NASA in this area are somewhat experimental in nature, and the program is in a continuing state of change.

Potential recipients of aerospace-derived technology are (1) the aerospace/defense industry itself, (2) the civilian industry section of the economy, and (3) the general public at large. The aerospace/defense industry itself is the largest recipient of aerospace technology because initial justification for research and development activities is derived from the needs of the nation's defense, aviation, and space activities. The civilian sector of the economy consists of Federal and state government agencies, medical and academic activities, as well as civilian industry in such fields as communications, meteorology, topography, and oil exploration as potential users of aerospace technology. Consideration of the general public as a recipient of aerospace technology is necessary to insure the future in that political activity will merge with public opinion in the long run.

Dissemination of formal technical publications to the aerospace/defense industry is based on a computerized storage and search reference system. Publications from both within and external to NASA are reduced to microfiche copy, indexed, and the abstract recorded on updated computer tapes at frequent intervals. Updated computer tapes are distributed to various aerospace facilities around the country. These facilities provide computerized retrieval and search services for new reference material on specific subjects. New technical publications are also announced through complimentary abstract journals, STAR and IAA, which are sent to various companies and libraries around the country. Copies of desired publications may be ordered from the Government from these abstract journals and computer reference services. Prospective users may also get on mailing lists to receive NASA reports at the time of publication. The system is continually being revised with the ultimate objective of (1) broadening the information base stored in the sytem, (2) being more accessible to the user, and (3) providing the actual information itself rather than reference to a document.

An additional aid to the technology transfer process is NASA support of various trade association activities. This support is in terms of authorizing employees of both NASA and contractors to author papers, journal articles, etc., and to hold offices within the various technical societies. Some financial aid is also provided for services such as report translations and cataloging. Trade association activities provide additional channels of distribution for technology and serve as an important communications link with research and development activities of foreign countries.

Shop- or production-orientated technical innovations as well as formal technical publications are transferred to the civilian industry segment of the economy under the Technology Utilization Program. Contractor-derived as well as NASA-derived technical innovations are described in short announcement-type publications which are distributed to various organizations by mailing lists and through Regional Dissemination Centers which are designed for non-aerospace users. Conferences are also sponsored to tell industrial representatives what is available and to acquaint them with the program. Various other activities are conducted under the Technology Utilization Program such as the transfer of NASA-derived computer programs, aid in the fields of medical research and public sector problems, creation of educational enrichment materials, and cooperative programs with other agencies. Analysis activities are underway to update the program and eliminate unproductive features as quickly as possible.

Technical innovations are announced to the general public through NASA Public Affairs activities. These activities are based on a policy of "soft-sell." Full cooperation with the news media is maintained, and tours of NASA facilities by the public are encouraged. Purchase of advertising time or space is not authorized, however. Advertising copy of contractors showing relation of products with NASA-sponsored research and development must be approved by NASA Headquarters prior to publication. Technical innovations which can be made into "good stories" are distributed by mailing lists to various news media which cover over eighty percent of the U.S. population.

NASA's patents and license regulations are a further aid to the transfer of technology in that they encourage commercial use of aerospace-derived inventions. All inventions developed either under contract to or from within NASA become the property of NASA. The original contractor who develops an invention under contract to NASA may receive a waiver of rights from NASA if it is in the public interest to do so, however. He may then patent the invention and develop it to commercial utility. If rights have not been waived, royalty-free licenses are available to industry for use of NASA-owned inventions. Usually such licenses are on a non-exclusive basis, but exclusive licenses are available in some instances to encourage commercial use of an invention.

Conclusions

The impact of the national space program has been felt in virtually all industries. In spite of its success, there is an "understanding gap," that is, an awareness of a vast program but not a general understanding of how the space program does help both the public and the economy. Much of the space-related technology and capability is unexplored in the civilian economy because of the lack of understanding. Technology transfer efforts have been extremely successful in some areas but severely lacking in others. With respect to specific parts of NASA's technology transfer activities, the following conclusions can be drawn from this study.

(1) The system of computerized storage and search services for technical publications is highly successful in transferring technology to the aerospace/defense industry, and it is advancing rapidly in an effort

to deal with the large amount of technical data being published each day in the world's scientific laboratories.

(2) Trade association and professional society activities are an important part of the technology transfer process.

(3) The Technology Utilization Program is highly successful in transferring technology to civilian industry in spite of its complexity and relative newness as evidenced by its rapid growth, many improvements, and expanding user list.

(4) NASA's policy of "soft-sell" concerning publicity activities is a problem in that only a few technical innovations get publicized, and one of the major benefits of the space program is hidden from the general public.

(5) NASA patent and licensing policy is flexible and apparently well geared for technology transfer based on recommendations of a recent study of Government patent policy.

Recommendations

A single study such as this one cannot form the sole basis for complete revision of a federal agency's policies. Many items go into the makeup of major policy, and most of these facts are not obtainable by an "outsider." A study such as this can recommend a reexamination of policy, however, based on the material examined during its execution. Based on the conclusions of this analysis, it is recommended that NASA reexamine its "soft-sell" policy concerning publicity activities, particularly in areas relating to the Technology Utilization Program.

Specific recommendations concerning the Public Affairs and Technology Utilization Programs are:

(1) Revision of policies concerning approval of contractor advertising and possibly providing some incentive for mention of NASA when feasible and in good taste.

(2) Creation of colorful documentary movies describing the Technology Utilization Program and patent opportunities for use by movie theaters and television stations as short-subject material.

(3) Additional publicity concerning available patents such that very small businesses are aware of new advances

(4) Examination of techniques used by the Department of Agriculture to reach the nation's farmers as a possible source for additional methods of technology transfer.

Proper technology transfer must take place if both the public and the various sectors of the economy are to be aware of the true value of aerospace research and development.

APPENDIX

MARKETING PRACTICES IN THE AEROSPACE INDUSTRY

Until recently the marketing and aerospace communities paid little attention to each other. Even today people outside the industry underestimate the attention given to marketing activities. It has been said[1] that prior to 1960, aerospace firms were fixated at the technical stage of development where administrative efficiency became secondary in status. This was the result of the large technical transition from (1) aircraft to missiles, (2) production to research and development activities, and (3) relatively simple to extremely complex systems. Administrative efficiency was forced by the large use of incentive contracting by the Government around 1961. Chronologically, the aerospace industry entered the worlds of management and marketing at this time. Emphasis has been shifting from engineering and accounting skills to those related to marketing activities. Typically the shift has taken place within the industry following four basic steps or stages. Initially the firm would only possess a rudimentary understanding of the marketing task and reliance would be placed on "proposal teams" formed in its engineering organizations. Proposals and new product ideas would be based largely on rumors and "piecemeal" information concerning future

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[1]William H. Reynolds, "The Marketing Concept and the Aerospace Business," Journal of Marketing, XXX (April 1966), pp. 9-11.

customer intentions. Many small aerospace firms operate in this manner today. The second step in the shift came when the future requirements or future projects groups was given formal status in the organization. Charged with planning and analysis responsibilities, formal debriefings to management were entered into the decision-making process. At this stage of development, however, the matching of capabilities with customer intentions was still looked on primarily as an engineering task. The third step in the shifting process is considered to be when a marketing organization was set up outside of the company's engineering organization. This was usually the result of the firm realizing that too much emphasis was being placed on company technical capabilities and not enough on customer desires and needs. The final step in the shift is when new kinds of people are brought into the organization and new tasks are undertaken. Planners, market researchers, economists, and other specialists are added. These marketing personnel are often hidden in the depths of the organization in departments of contract administration or technical representative. Cost effectiveness of alternative systems or products are studied, and the results are actually used to reorient and direct engineering and development tasks.[2]

Characteristics of the aerospace industry are different enough from civilian to warrant separate marketing techniques in most larger aerospace companies. Differences lie in the market in which the product is consumed, the marketing methods involved, and

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[2] Ibid.

the purpose for which the product is purchased.[3] Somewhat unique to the aerospace market are (1) sometimes unusually large commitments of company funds for contract proposals, (2) the use of incentive-type contracts, (3) political as well as technical considerations, and (4) possibilities of commercial diversification. The aerospace organization is faced with the problem of optimizing its allocation of company funds such as to maximize its competitive position. Gathering, evaluating, and cataloging of both technical information and marketing data is required such that forecasts are realistic and new product opportunities are identified. Optimization models are often utilized to aid in the proper selection of products within limitations of allocated resources. A major use of funds is often the construction of prototype hardware such that the company is the sole source of the product. The use of incentive contracting has introduced the requirement for early recognition of the most controllable portions of the project or contract such that the final negotiated profit formula stresses areas most beneficial to the company, rather than the purchaser. The final profit will reflect the company's response to the incentives of the contract and the ability of the marketing people to optimize the formula prior to negotiations.

Today the modern aerospace firm must have production and engineering staffs to deal with real world processes as well as financial-administrative-management staffs to assure smooth-running operations internally. Vigorous marketing organizations are required

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[3] A. W. Frey, Marketing Handbook (New York, The Ronald Press Co., 1965), Section 27, pp. 5-7.

to properly relate the firm to the larger external environment through the gathering, evaluating, and cataloging of both new technical information and marketing data in terms of customer requirements and desires. Large company commitments to projects with an improper balance of technical capability and customer desire has brought companies to the brink of disaster.[4] The modern aerospace firm must be aware of the very latest technology as well as what new knowledge may be available tommorow such that new products or prototype hardware are not obsolete before they can be produced. An efficient system for technology transfer is of vital importance in the marketing practices of the modern aerospace organization.

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[4] Warren E. Kraemer, "The Technology Trap: Too Much, Too Soon," Innovation, (May 1969), pp. 20-28.

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