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AIR FORCE TECHNOLOGY TRANSFER FOR NON-DEFENSE NEEDS

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AIR COMMAND AND STAFF COLLEGE

AIR FORCE TECHNOLOGY TRANSFER FOR NON-DEFENSE NEEDS

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A RESEARCH STUDY SUBMITTED TO THE FACULTY

May 1973

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AIR UNIVERSITY

MAXWELL AIR FORCE BASE, ALABAMA

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EXTENDED ABSTRACT

Introduction

This study addresses the subject of technology transfer with special emphasis on the transfer of AF technology for non-defense applications and the needs of the civil sector. Commonly referred to as technology spin-offs, this investigation was designed to analyze technology spin-off in terms of a systematic, intentional transfer of technology to organizations outside the Air Force rather than the random, profit driven spin-off that normally occurs throughout industry. The subject has recently been given impetus by Congress, the Executive Branch, Small Business Administration, State and local governments as reflected by their increasing demands to utilize the advanced and costly technology of DOD and the Defense Agencies to meet the growing needs of society.

Purpose

The specific objectives of the study were to assess: (1) the extent of current AF participation in technology transfer (2) the advantages and disadvantages associated with an expanded technology transfer program and (3) ways and methods to realize more optimal use of the Air Force RDT&E budget to satisfy both defense and domestic needs.

Conclusions (pgs 124, 125)

The most significant findings and conclusions of the study were:

1. Support programs and technology transfer activities are occurring at the laboratory/center level on a random basis.

2. The documentation of interagency agreements and other technology transfer efforts is dispersed throughout several offices at AFSC Headquarters.

3. The lack of tracking and publicity concerning significant technology spin-offs through a focal point at AFSC Headquarters has led to insufficient awareness of the AF contribution to the civil sector at DDR&E, Executive Branch and Congress.

4. In the present austere financial climate, active transfer agents are absolutely critical in cutting across organizational boundaries and matching technological capabilities with potential user's needs and vise versa to realize the better utilization of the technical resources of the Air Force and other Federal agencies.

5. An integrated, expanded Air Force technology transfer program requires the positive endorsement (including specific guidelines) of senior management at Headquarters AFSC and AF, the designation of a focal point at AFSC level for tracking, monitoring, and coordinating

ments, etc.) only represented the potential for non-military applications and merely suggested areas of possible interest to civil agencies or the civilian economy. In

SBA technology utilization office, and the technology transfer contacts of other Federal civil agencies, State, and local governments.

2. The maintenance of records containing all interorganizational agreements involving the laboratory and incorporation of the STINFO function.

3. The compilation and transmittal of laboratory technical advances, documents, and unique facilities/capabilities that may offer technology potential to outside agencies. Develop techniques such as AFAL TRACE abstracts for dissemination to outside users. (Refer to page 12.)

4. The interaction with the laboratory Plans Office and laboratory engineers when programs, facilities, and capabilities outside the laboratory may possibly be p

all technology transfer activities involving the laboratories, and the implementation of ways and methods to enhance visibility to upper level management and the American public.

<u>Recommendations</u> (pgs 126 to 128)

The significant recommendations of this study were:

1. The tracking and use of a mechanism such as a brochure to publicize the current AF contributions to non-defense needs of society can be of major benefit to the Air Force in improving its image with DOD, Congress, and the American public. This recommendation is of the highest priority.

2. The designation of the Applications Office at the laboratory level and the Scientific and Technical Liaison Division (AFSC/DLXL) at AFSC as focal point for all passive and active technology transfer activities involving the laboratories is essential to a flexible, coordinated technology transfer program.

3. Air Force R&D support to outside agencies should be oriented towards cooperative, mission-related efforts and those non-defense projects which require the unique facilities and capabilities of the laboratories and be given the positive endorsement of AFSC and Air Staff management.

4. The potential benefits of an integrated, expanded technology transfer program warrant a further detailed study by AFSC and/or DCS/R&D at Air Staff.

ABSTRACT

The Federal government has increased the pressure on the Department of Defense to adapt defense-related technologies to the solution of current social problems facing the nation. The Air Force is confronted with the expanded responsibility of providing technology for both military and domestic needs. This study addresses the transfer of Air Force developed technology for non-defense needs in terms of the relevant policies, regulations, and procedures; the present level of participation; and the barriers and benefits related to an expanded technology transfer program. Proposed solutions and recommendations for the implementation of an integrated technology transfer program are offered.

PREFACE

This study group was initially formed to consider the subject, "The Contribution of US Military Technology to Economic Growth." The specific objective was to have been to investigate the extent to which military technology changes have contributed to the growth of other sectors of the national economy. The authors were all intrigued by the original problem statement. However, it soon became evident while attempting to "redefine, narrow, and focus the study in more meaningful terms," that the problem as stated was beyond the scope of this effort.

Indeed, it became apparent that a much more dynamic and challenging problem to be addressed is the impact that President Nixon's Message to the Congress on the subject of "Science and Technology" would have on the Department of Defense, the Air Force, and the Air Force Systems Command. For this reason, the study group directed its efforts to the analysis of technology transfer which follows.

Even if the analysis never proceeds beyond the shelves of the Air University Library, it will still have been valuable. The mere act of gathering information has served as a catalyst to speed up the reaction between various agencies which are directly concerned with technology transfer. The authors found themselves in the position of "third-party transfer agents" on more than one occasion. If nothing else is accomplished, the system has been perturbed and reactions have occurred which may have long term beneficial results.

Hopefully, the effort will not terminate with this report. The dynamic nature of the subject, coupled with a high level Congressional and DOD interest, make this a worthy topic for future ACSC group study. Should this be the case, the authors wish to emphasize the essential requirement for travel in order to conduct personal interviews. This study could not have been completed without the interviews conducted at AFSC laboratories at Wright-Patterson AFB, Headquarters AFSC at Andrews AFB, and DOD offices in the Pentagon. Liberal use was made of the telephone, but personal contact was essential. The authors firmly believe that Air Command and Staff College policy should provide future study groups with increased opportunity to travel, preferably at government expense. A few words on the qualifications of the investigators is in order at this point.

Major Larry L. Fehrenbacher has ten years experience in basic and applied materials research during two tours at the Air Force Materials Laboratory and the Aerospace Research Laboratories. Most of his research has been concentrated on property measurements of new refractory oxide compositions and has included studies of phase transformations, room and high temperature deformation, and combined electrical and thermogravimetric behavior. These efforts resulted in 26 technical publications and 19 presentations at national scientific meetings and symposia. The knowledge gained from this work has been applied to a variety of practical Air Force needs. Major Fehrenbacher received his PhD in Ceramic Engineering from the University of Illinois under Air Force Institute of Technology sponsorship. His follow-on assignment from ACSC is to the position of Assistant Division Chief, Systems Support Division, Air Force Materials Laboratory.

Major Larry E. Cress is an R&D Electronics Officer with a Master of Science Degree in Research and Development Systems Management. He has diverse experience in missiles and space projects. His early career experience was with ballistic missile systems engineering (Atlas E, Atlas F, Titan I, and Titan II) in Air Force Logistics

Command. Following receipt of his Master's Degree, he worked with a range of space satellite boosters (e.g., Thor and Titan) in conjunction with Air Force and NASA space experiments. His duties have included engineering management responsibilities over a number of civilian technical support contracts for hardware and software. His follow-on assignment from ACSC is to AFSC's Space and Missile Organization (SAMSO).

Major Justin A. Curtis is an R&D Staff Officer with a Master's Degree in Astronautics and is a candidate for a PhD in Aerospace Engineering. He has served in AFSC as a project officer in the advanced development of the Atlas ICBM weapon system, as a launch officer in the Scout Missile Program, and as a physicist at the Aerospace Research Laboratories. His follow-on assignment from ACSC is as Chief of the Technology Development Division, SAMSO.

Major Charles C. Hansult is a pilot with operational experience in SAC and as an Air Liaison Officer in Southeast Asia. He holds a Master's Degree in Engineering Mechanics from Oregon State University, and has instructed in Mechanics and Materials Science at the United States Air Force Academy. Major Hansult's experience in Systems Command has included duty as a project engineer, Assistant Branch Chief, Assistant Division Chief, and Executive Officer of the Air Force Materials Laboratory. His follow-on assignment from ACSC is to Headquarters AFSC, where he will serve as the Executive Officer to the Director of Science and Technology.

Finally, the authors wish to express their gratitude to all who contributed their thoughts and ideas on this very knotty subject. Their frankness and candor were essential to the success of this effort.

The development of the sizeable manuscript which follows is consistent with the academic philosophy of Air University research study requirements. However, the inhibitive nature of its length can be alleviated by reading only Chapter VII and VIII which serve essentially as an executive summary.

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LIST OF ACRONYMS

ACSC	Air Command and Staff College
AEC	Atomic Energy Commission
AFADTL	Air Force Armament Development Test Laboratory
AFAL	Air Force Avionics Laboratory
AFAPL	Air Force Aero Propulsion Laboratory
AFCRL	Air Force Cambridge Research Laboratory
AFFDL	Air Force Flight Dynamics Laboratory
AFML	Air Force Materials Laboratory
AFOSR	Air Force Office of Scientific Research
AFRPL	Air Force Rocket Propulsion Laboratory
AFSC	Air Force Systems Command
AFWL	Air Force Weapons Laboratory
AMRL	Aero Medical Research Laboratory
ARL	Aerospace Research Laboratories
ARPA	Advanced Research Projects Agency
ASD	Aeronautical Systems Division
CNO	Chief of Naval Operations
DDC	Defense Documentation Center
DDR&E	Director of Defense Research and Engineering
DDR&E (R&AT)	Director of Defense Research and Engineering (Research and Advanced Technology)
DOD	Department of Defense
DOL	Department of Labor
DOT	Department of Transportation
DPPG	Defense Policy and Planning Guidance
DRS	Defense Research Science
EDECT	Elimination of Direct Hire Ceilings
EPA	Environmental Protection Agency
ERIC	Educational Resources Information Center
ESP	Engineering Service Program
FAA	Federal Aviation Administration
FCST	Federal Council for Science and Technology
FJSRL	Frank. J. Seiler Research Laboratory
FYDP	Five-Year Defense Program
GAO	General Accounting Office
HEW	Department of Health, Education, and Welfare
HUD	Department of Housing and Urban Development
IR&D	Independent Research and Development
JCS	Joint Chiefs of Staff

JRDOD	Joint Research and Development Objectives Document
JSOP	Joint Strategic Objectives Plan
MASIS	Management and Scientific Information System
MHD	Magentohydrodynamics
MIPR	Military Interdepartmental Purchase Request
NASA	National Aeronautics and Space Administration
NBS	National Bureau of Standards
NIH	Not Invented Here
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
NTIS	National Technical Information Service
NWC	Naval Weapons Center
OCR	Office of Coal Research
OMB	Office of Management and Budget
OPR	Office of Primary Responsibility
OSD	Office of Secretary of Defense
PAR	Planning Activity Report
PEG	Program Evaluation Group
POM	Program Objective Memorandum
PPBS	Planning Programming and Budgeting System
PPGM	Planning Programming Guidance Memorandum
R&D	Research and Development
RADC	Rome Air Development Center
RANN	Research Applied to National Needs
RDC	Regional Dissemination Center
RDT&E	Research, Development, Test, and Engineering
REFLEX	Resource Flexibility
RN	Research Need
RO	Research Objective
ROC	Required Operational Capability
RPG	Research Planning Group
S&E	Scientific and Engineering
SALT	Strategic Arms Limitation Talks
SAMSO	Space and Missile Systems Organization
SBA	Small Business Administration
SCP	Systems Concept Possibilities
SEA	Southeast Asia
SIC	Standard Industry Classification
SPO	Systems Project Office
SRL	Systems Research Laboratory
SST	Supersonic Transport
STINFO	Scientific and Technical Information
STLD	Scientific and Technical Liaison Division
STOL	Short Take-off and Landing
TA	Technology Advance

TAC	Tactical Air Command
TATeam	Technology Applications Team
TCP	Technology Coordination Paper
TN	Technology Need
TOD	Technical Objective Document
TPG	Technology Planning Guide
TPO	Technology Planning Objective
TU	Technology Utilization
TUO	Technology Utilization Office
TUP	Technology Utilization Program

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CHAPTER I

INTRODUCTION

> An asset unused is an asset wasted. Federal research and development activities generate a great deal of new technology which could be applied in ways which go well beyond the immediate mission of the supporting agency. In such cases, I believe the Government has a responsibility to transfer the results of its research and development activities to wider use in the private sector.
>
> Richard M. Nixon (52:5)

Statement of the Problem

President Nixon's Message to Congress on Science and Technology made it clear that the responsibility to transfer the results of research and development activities to the civil sector extends to all levels of the Federal establishment. Since the Department of Defense (DOD) conducts more than half of the research and development (R&D) funded by the Federal government, and since the Air Force receives a significant portion of these funds, the Air Force should assume its share of the responsibility and establish a program designed to systematically transfer its unique, advanced technologies into applications which contribute to the future well-being of the nation.

Objectives of the Study

The purpose of this study is to assess the impact upon the Air Force of national interest in the transfer of Federally developed technology. The study will also show that it is in the Air Force self-interest to actively participate in technology transfer to the civil and private sectors. The specific objectives of this research effort are to:

1. Identify the policies, regulations, and authority for accomplishing technology transfer.

2. Analyze the machinery and effectiveness of the present Air Force system of disseminating R&D results and providing support to outside agencies.

3. Examine the impact of existing barriers and the proposed advantages on increased Air Force involvement in technology transfer.

4. Evaluate the current system of coupling and interfacing of Air Force R&D components with each other and with industry in accomplishing the Air Force defense mission objectives.

5. Propose methods that offer the Air Force the

opportunity to develop an integrated program to provide direct support to outside agencies and to actively stimulate and improve the transfer of Air Force generated technology, thus contributing to both the domestic needs of society and the defense mission.

Limitations

Because of the dynamic and complex nature of the stated problem, the authors doubt that this study will have an immediate, direct impact on DOD or Air Force policy with respect to technology transfer. The restrictions of time and the academic requirements of the Air Command and Staff College (ACSC) curriculum have made it necessary to terminate the collection of data and information in order to complete the effort during the course of the school year. Therefore, some of the conclusions reached may well be overtaken by events even as they are being written.

Material for this study was obtained from a variety of sources. Although the bibliographical listing reveals a wealth of written material on the subject (much of which cannot be found in any library), much of the most valuable material was obtained through personal contact and telephone conversations with personnel in the Office of the Director of Defense Research and Engineering, the National Science Foundation, the General Accounting Office, the Air Force Systems Command Headquarters, the Air Force Headquarters, the Air Force Institute of Technology, various Air Force Systems Command Laboratories, the Small Business Administration, other civilian agencies, and certain defense contractors.

Since much of the material, both verbal and written, was obtained through personal contact, the authors were severely limited by the inability to travel extensively. One trip to Washington, DC, and one trip to Wright-Patterson AFB were performed on ACSC time and received official sanction. Several other trips were made by individual members of the study group on their own time and at their own expense. Unfortunately, travel restrictions prevented the authors from contacting all the valuable sources of current and pertinent information. For example, scheduling conflicts prevented meeting with Dr. A. M. Lovelace, Director of Science and Technology, Air Force Systems Command, an individual whose opinions on the topic would certainly have proven invaluable.

An additional word of caution to the reader is appropriate. Many of the most firmly held opinions were expressed verbally with a request for non-attribution.

Therefore, much of what follows is of necessity put forth as opinion with little or no documentary support. The authors regret this apparent weakness of the study, but feel that the message is clear and the conclusions are valid. To have exluded that material which was provided "off the record" would have resulted in an acceptable but inaccurate report.

A few words on the scope of the study are also in order. For the purposes of this report, the authors are primarily, but not exclusively, concerned with the transfer of that technology which is either directly transferable or which requires only a small amount of adaptive engineering to accomplish the transfer, giving first priority to cooperative efforts that are directly related to the defense mission. This will insure transfer with a minimum expenditure of DOD resources and yet retain the potential for significant payoff in the civil sector. In addition, the authors rely upon the multitude of studies and papers which analyze the channels of communication involved in the technology transfer process itself and concern themselves primarily with why the Air Force should encourage technology transfer, and how the process can be enhanced.

Concepts and Definitions

No study of this type would be complete without a section devoted to an explanation of concepts and definitions. Such a section is necessary in order to insure that the semantic barrier to communication is removed and that the authors and the reader share a common base upon which to build.

Technology. There are many definitions of "technology" which differ primarily according to the technical depth, perception, or experience of an individual or group. Technology encompasses diverse scientific fields and disciplines. A report of the General Accounting Office (GAO) entitled "Means for Increasing the Use of Defense Technology for Urgent Public Problems" has served as a valuable source of definitions and ideas for this study. This report states that "technology or a technological resource" may be defined as any: (1) hardware device, (2) equipment or system, (3) scientific knowledge, (4) engineering design or process, (5) special laboratory or test facility, or (6) specially trained person. (41:5) For the purpose of this study, "technology" may refer to any of the above or similar concepts.

Technology Transfer. "Technology transfer" is the process of making technology available to a user other than the originator. The GAO report defines technology transfer as the "secondary application of technology developed for a particular mission or purpose to fill a different need in another environment." (41:5)

Mr. Joseph G. Berke, writing under a contract to the National Aeronautics and Space Administration (NASA), provides still another definition of technology transfer. The NASA definition is expressed in terms of first-, second-, or third-order transfer:

> 1. A first-order transfer is one where NASA is working in an area directly related to that of the user (e.g., Langley runway skid tests and the problem of skidding on the highways).
>
> 2. A second-order transfer is one where the user and NASA share a common discipline but not common problems (e.g., in the area of criminalistics, certain new laboratory procedures or innovations within NASA may be adapted to the user's problem).
>
> 3. A third-order transfer is defined as one where a solution comes from a set of NASA problems and disciplines completely unrelated to those of the user. (65:21)

Translated into terms of this study, NASA's definition specifies the transfer process for the level of technology required to solve the problem of a secondary user. In a first-order transfer, simply providing problem-solution documentation and attendant advice will assist in solving the problem. This is true whenever the information can be used as is or whenever the user has the ability to adapt it without further assistance. A second-order transfer will require some development or adaptive engineering to make the in-hand, state-of-the-art technology applicable to the solution of the problem. Third-order transfer encompasses everything which requires more than adaptive engineering in order to satisfy a secondary user's need. Even though additional basic research may be required to find a solution to the problem, the transfer process is involved if the supplier furnishes technical ability and/or facilities.

Transfer can be accomplished either by providing the secondary user with the necessary resource, or through joint use of the resource by the primary and secondary user. The provision of technical data on a composite material from a laboratory to an interested agency is an example of the first type of transfer. Joint funding of a common-use laboratory program by an agency with no self-contained technical expertise is an example of the second type of transfer.

Transfer Mechanisms. Technology transfer mechanisms include but certainly are not limited to:

1. Scientific and other technical documents and publications.

2. Computerized data banks and services.

3. Professional, scientific, and technical society symposia.

4. Special technology conferences.

5. Intergovernmental technology committees.

6. National standards and military specifications committees.

7. Technology liaison staffs.

8. Interagency joint ventures.

9. Informal personal contacts.

10. Interagency sharing of Federal laboratories and test facilities.

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

12. Technology transfer agents.

13. Small Business Administration technology utilization officers.

14. State technical services programs.

15. The Extension Service, Department of Agriculture. (41:7)

These technology transfer mechanisms fall into three categories: passive transfer, active transfer, and technological spin-off.

Passive Transfer. The GAO report describes passive mechanisms as those which involve "collecting, screening, indexing, storing, and disseminating scientific and technical information upon request of a potential user." The effectiveness of passive mechanisms:

> . . . depends upon such factors as the requester's ability to define the technology sought; the procedures used to search and identify requested information; the format in which the information is furnished to the requester; and the ability of the potential user to assimilate the knowledge, evaluate the relevance, and adapt the technology. (41:8)

Active Transfer. Active technology transfer mechanisms include elements of the passive mechanisms supplemented by personal liaison between the developers and the potential users of the technology. Third party transfer agents frequently aid in the process by helping to define user agency problems and by identifying existing relevant technology. (41:8) Active transfer often involves the sharing of laboratory test facilities and equipment.

Spin-off Transfer. This technology transfer mechanism is currently the most commonly employed. Spin-off may be defined as the direct application of specific technology to a secondary use. Because spin-off occurs naturally and therefore falls in a category quite different from the other transfer mechanisms, it is of little importance to this study. A classic example of spin-off is the adaptation of DOD-contracted military aircraft technology to the design and construction of improved commercial aircraft. (20:1]; 133:5,6)

Dr. M. Frank Hersman, in his speech entitled "Technology Utilization in the Public Sector," introduces an alternative method of classifying technology transfer mechanisms. He points out that, "Existing mechanisms directed toward technology utilization can be categorized into four groups: clearinghouse, communication, training, and change agents." Of these, the first two are common to nearly all programs. (75:7)

Clearinghouse. This is the most passive of Dr. Hersman's four transfer mechanisms. The potential user must take the initiative and seek out information on available technology through such organizations as: (1) Educational Resources Information Center (ERIC) of the Office of Education, (2) Regional Dissemination Centers of NASA, (3) National Technical Information Service (NTIS) of the United States Department of Commerce, (4) Smithsonian Science Information Exchange, (5)National Referral Center of the Library of Congress.

Communications Activities. This mechanism is very similar to the clearinghouse but is slightly more active, because the technology developers employ communications media to publicize their product. Examples include the Research and Demonstration BRIEF (Bring Research Into Effective Focus) which is issued by the Research Utilization Branch of the Social and Rehabilitation Service of the Department of Health, Education, and Welfare (HEW). The Small Business Administration publishes the Tech Aid series, BRIEFS, and the Air Force Avionics Laboratory (AFAL) publishes TRACE (Technical Report Analysis Condensation Evaluation) to announce the release of technical reports of AFAL contractors.

Training Activities. The next step up the activity ladder finds training activities which include the conferences, workshops, courses, and manuals presented and prepared by various organizations. For example, the AEC conducts an education program to broaden the nuclear technology manpower base, the Department of Housing and Urban Development (HUD) conducts conferences and workshops on advanced systems for project housing, and the Environmental Protection Agency (EPA) prepares manuals for the use of design engineers to prevent the construction of municipal waste water treatment and control facilities using obsolete technology.

Change Agents. The most active of Dr. Hersman's four basic mechanisms is the change agent, which is comparable to the more commonly accepted term, transfer agent. The most widely recognized example of change/transfer agents is the county agent system of the United States Department of Agriculture Extension Service. This mechanism includes those functions or individuals who perform the task of supplying technology to users. A transfer agent may be associated with either a supplier or a user, or he may be a third party whose job it is to connect users and suppliers. In discussing transfer agents, the GAO report observes, "An interdisciplinary third-party transfer agent team often bridges the possible communications gap between technology developers and potential users and helps with the transfer. The team would help to optimize the match between users' needs and the resource potential." (41:8) The third party transfer agent is also referred to as a "clearinghouse" agent or "broker" since he acts in the interests of parties other than himself. The "broker" concept is strongly advocated by many of those individuals involved in technology transfer and seems to offer the most promise for effective transfer.

Personnel Mobility. The transfer of personnel with the expertise necessary to address a secondary user's problems is an emerging mechanism of technology transfer. Although this mechanism has enjoyed great success in specific instances, it is not considered to be an effective way to transfer technology on a large scale. (75:8) The authors have personally observed this mechanism applied <u>within</u> an Air Force Systems Command (AFSC) laboratory and found it to be effective in stimulating fresh thinking and providing innovative approaches to old problems. This mechanism partially satisfies a need for effective transfer within and between DOD laboratories.

Organization of Study

This study is organized into seven major parts. Chapter II briefly discusses some of the factors which constitute the background for the material to follow. Awareness of the need for technological solutions to certain problems in the civil sector, the extent of Federal involvement in research and development, and the importance of the Federal role in technology transfer are examined. Chapter III rounds out the background material by analyzing and summarizing the existing policies of the Executive Branch, the Congress, the Department of Defense, the Air Force, and other Federal agencies with respect to technology transfer.

Chapter IV presents a summary of current technology transfer efforts within the government. These efforts are generally conducted on an informal *ad hoc* basis and meet with varying degrees of success. The Navy technology transfer program, in conjunction with a DOD consortium of laboratories, is examined as a potential model for expanded Air Force involvement. Chapter V delves into the advantages which will be realized by increased Air Force activity in this area. The chapter also discusses some of the barriers to acceptance of such an effort.

Chapter VI examines both the present methods by which technology is transferred from basic research and exploratory development to systems applications within the Air Force, and, the coupling which occurs between the Air Force and industry during the process of fulfilling defense mission requirements. In addition, present methods and procedures for providing direct support to outside agencies are surveyed.

Chapter VII proposes suggestions for overcoming many of the barriers discussed in Chapter V and presents alternative ways to expand Air Force technology transfer efforts.

Finally, Chapter VIII summarizes the conclusions and recommendations of the study group.

CHAPTER II

BACKGROUND

> . . . properly nurtured and directed, technology is a tremendous power source for good that can serve us with almost endless solutions to our human problems and needs.
> Lt. General Kenneth W. Schultz (133:18)

Lt. General Schultz's statement refers to several factors relevant to the present situation in the United States. First, he acknowledges that the country is currently faced with social problems which transcend governmental jurisdictions and permeate all sectors and institutions of our society. Second, he proposes that the solutions to at least some of these problems may be found through the application of technology. And, third, he implies that this application of technology must be "properly nurtured and directed." In order to set the stage for the material to follow, this chapter will briefly survey the recognition of the need for solutions to national problems, the potential roles of technology and the Government in addressing the need, and the response of the Federal establishment.

Recognition of Need

The current situation can perhaps be best described as one in which greater demands are being made upon our limited resources. One of these demands has been created by the increased national commitment to solve the problems confronting society. The Committee on Intergovernmental Science Relations recently pronounced, "The current shift of national priorities is leading to major shifts in Federal programs to meet domestic needs." (45:1) The problems are real, and the needs are justified. New agencies have appeared in the Federal government to address such problems as transportation, law enforcement and crime prevention, environmental protection and pollution control, health and education, and housing and urban development.

In addition to the Federal government's recognition of these problems, many local, State and regional governments and groups are expressing concern about the need for solutions to correct current ills. Mr. Jack Campbell, President of the Federation of Rocky Mountain States, in an address to the Council of State Governments, stated that:

> New kinds of social problems begin to concern our Nation. Abolishment of poverty, improved

law enforcement, equal educational opportunities, better transportation systems, better housing, environmental deterioration, peaceful uses of atomic energy all become matters of national urgency . . . (42:x)

Role of Technology and Government

Although people often take for granted the role that technology has played in enriching their lives, Mr. William Magruder, Special Assistant to the President on Science and Technology, recently said, ". . . high technology industries help to provide this nation with dual benefits: the enjoyment of the highest standard of living in the history of the world, and, at the same time, a competitive industrial system in world trade." (128:4) President Nixon acknowledged the role of technology in his message to Congress when he stressed the use of the technological resources of the nation to find solutions to these problems, to improve the overall standard of living, enhance the growth of the economy, and reduce the international balance of payments deficit. (52)

Some of the State and local governments also appreciate the importance of technology in the solution of their problems. Mr. Campbell went on to say, "Science and technology, properly marshalled, can help the States enormously, if we can but find the ways to use them effectively." (42:x)

Finding ways presents a real challenge, however, since State and local governments lack both the technical expertise and the funds to seek out solutions on their own. At present, State and local governments spend only one percent (including Federal grants and assistance) of the amount spent by Federal agencies. (45:1) Necessarily, the State and local governments are becoming more cognizant of the technology available within the Federal system. The report, "Technology for the Cities," states:

> Many of the cities firmly believe that the vast amount of the research and development conducted over the past several decades to meet the nation's space and national security missions has yielded new technologies which should be of benefit to their problems. (59:2)

The importance of the Federal government to research and development in the United States cannot be overestimated. As President Nixon pointed out:

> Of all our Nation's expenditures on research and development, 55 percent are presently funded by the Federal Government. Directly or indirectly the Federal government supports the employment of nearly half of all research and development personnel in the United States. (52:3)

Budget figures show that the amount of money appropriated for Federally funded research and development in FY 73 was 17.8 billion dollars. (14:14) The Department of Defense received approximately half that amount for defense-related R&D.

State and local governments express widespread dissatisfaction with this federally dominated system. The Committee on Intergovernmental Science Relations reported, "This attitude [of dissatisfaction] derives from a feeling of exclusion from the determination of research priorities and project selection as well as inadequate transfers of research performed or sponsored by the Federal government." (45:2) Although the civil sector does not place the entire blame for the current situation on the Federal government, Washington is held largely responsible since it holds ". . . a virtual monopoly on research and development related to the solutions of urgent [domestic] problems." (42:25)

Allocation of Resources Dilemma

The increased awareness of both the Federal government and State and local governments of the need to solve the critical problems of modern society, coupled with the realization that technology can make a significant contribution to the solutions, have created additional demands upon the resources available for research and development. Since additional funding will probably not be provided on a large scale, the public and Congress express the desire to squeeze the necessary resources from the Department of Defense share of the budget. While it is true that the overall Federal budget for research and development has grown slightly in recent years, the DOD share is at best holding relatively constant at a time when increased demands in the form of increasing costs of hardware and personnel are being made upon it. In spite of the United States reduced involvement in Southeast Asia, the long-term military threat has not been reduced. Dr. John S. Foster, Director of Defense Research and Engineering (DDR&E), recently stated:

> . . . we estimate that with present trends, the Soviet Union will surpass us in terms of total defense-oriented technological capability somewhere between 1975 and 1978. . . . The conclusion of the SALT accord has not lead to any discernable reductions in the Soviet military research and development effort, whose level continues to top that of the United States by a considerable margin, probably by between 40 and 50 percent. (22:57)

Obviously, defense technology represents a major national resource that could potentially solve many of the domestic problems of the nation. However, the Department of Defense and the nation cannot afford to sacrifice a strong defense-oriented R&D capability in order to satisfy the high priority goals of the civil sector.

How can this conflict between defense and non-defense needs be resolved? A Navy document relative to R&D management states, "In this period of growing demands on limited national resources, it is important to pursue all methods which will bring about more effective utilization of available assets." (50:1)

The solution, therefore, is not to be found by diverting resources from defense-oriented R&D to non-DOD agencies, State and local governments, and the private sector. Instead, the solution lies in the proper application of all the technological resources of the nation. Historically, technological development has progressed from the military to the civilian sector. From specific defense applications, a chain reaction of developments into the civil sector spell progress and new opportunities for prosperity and higher standards of living. (133:5) Better management of the R&D capability of the government can resolve the dilemma and insure the continued contribution of technology to progress.

Need for Technology Transfer

Preceding sections have emphasized the importance of technology to the solution of national problems, and the necessity to better manage our national R&D capability.

Satisfying the demands of the civil sector without compromising national security requires that knowledge and technology be fully exploited. Research and development alone is not enough. The results must be put to work on a problem for a solution to be effected. Effective transfer of technology between the science and engineering components of DOD, non-defense agencies, industry, universities, and State and local government is required.

The need for systematic application and utilization of advanced technology on a broad scale is widely recognized. President Nixon eloquently expressed this need:

> . . . we must always be aware that the mere act of scientific discovery alone is not enough. Even the most important breakthrough will have little impact on our lives unless it is put to use--and putting an idea to use is a far more complex process than has often been appreciated. To accomplish this transformation we must combine the genius of invention with the skills of entrepreneurship, management, marketing, and finance. (52:2)

The Honorable James W. Symington, United States House of Representatives, summarized the awareness of the Congress when he said, "The Congress recognizes the urgent need for intergovernmental science and technology partnership . . . and it appreciates the responsibilities which it must assume in helping to bring about their development." (55:32)

Lt. General Kenneth W. Schultz, Commander, Air Force Space and Missile Systems Organization (SAMSO), stated that the systematic transfer of technology to the civil sector is one of the great challenges we face in the near future. He feels that the challenge must be met by:

> . . . the <u>systematic</u>, <u>organized</u> application of the new technology to the specific problems and goals of our society. We must use our systems engineering experience, techniques, tools, to mobilize the technological advances in many fields and mount them in concentrated, precisely planned and executed attacks upon our objectives. We must stop letting this technological revolution <u>happen</u> to us and start <u>causing it to happen</u> in ways and areas where we want it and need it most. . . . We must be prepared to make an extraordinary management effort to get maximum return from the resources made available to us. (133:2)

<u>Response of the Federal Government</u>

The expressed awareness of the Federal government for the necessity to assume the responsibility to encourage and promote the transfer of advanced technology in order to solve national problems has manifested itself in several ways. Positive responses have been generated by diverse Federal agencies, Congress, the General Accounting Office, and others. Several pilot programs have been initiated to examine the feasibility of Federal-to-civil sector technology transfer. Some of the more successful efforts are discussed in Chapter IV.

Other efforts at the national level designed to alleviate the economic difficulties and social problems of society are the National Science Foundation (NSF) program "Research Applied to National Needs" (RANN), and the Experimental R&D Incentives Program, which is a joint venture shared by NSF and National Bureau of Standards (NBS). The broad objective of RANN is contained in the program statement: "Activities supported by RANN will seek to increase understanding of social and environmental problems and their underlying causes, and to identify means for applying advanced technology for the benefit of society." (48:3) The Experimental R&D Incentives Program is designed to study ways and methods to stimulate the process of innovation and the transfer of technical expertise and to enhance the transition of R&D into new products, processes, and services which will contribute to improvements in the quality of life and the growth of the economy. (66:11)

The United States Congress has also indicated its interest in the effective utilization of the Federal R&D investment by society. The result has been the passage of legislation creating the Office of Technology Assessment and the proposal of legislation to create an

Office of Federal Technology Transfer. These and other Congressional policies which impact on the subject are discussed in Chapter III. Congressional interest was also partially responsible for the GAO analysis on technology transfer which was referred to earlier. This analysis revealed that approximately 1.5 billion dollars of the DOD R&D budget were spent in technology areas that are considered applicable and transferrable to non-defense needs. (41:9) The report emphasized the necessity for <u>active</u> transfer programs if valuable defense technology is to be profitably utilized in the solution of urgent public problems. In other words, the application of technology must be ". . . properly nurtured and directed."

CHAPTER III

POLICY

> I am therefore calling today for a strong new effort to marshal science and technology in the work of strengthening our economy and improving the quality of our life. And I am outlining ways in which the Federal Government can work as a more effective partner in this great task.
>
> Richard M. Nixon (52:1)

The previous chapter briefly examined some of the background factors which bear on this problem. The role of the Federal government, particularly the DOD laboratories, in transferring technology to the civil sector in order to assist in the solution of urgent domestic national problems was discussed. To fill in the background picture, the subject of official policy as it currently exists must be addressed. The present policy guidelines and rationale must be examined in order to fully understand and appreciate the existing state of technology transfer in the Air Force. In order to place Air Force policy in context and to determine whether or not it is consistent with the policies of other Federal agencies, it is first necessary to examine the policy guidelines issued by the President, Congress, non-DOD Federal agencies, Department of Defense, Department of the Navy, and Department of the Air Force. After these policies have been surveyed, the Air Force approach to technology transfer can be evaluated for consistency within the Federal framework. (See Appendix A.)

Executive Policy

The overall policy guidelines for the Federal framework of technology transfer were presented by President Nixon: "We should be doing more to focus our scientific and technological resources on the problems of the environment, health, energy, transportation, and other primary domestic concerns." (52:3) The President then outlined ways in which the Federal government could be a more effective partner in the task of harnessing science and technology for the needs of man. Consistent throughout his policy is the theme which stresses the need for cooperation:

> . . . the progress we seek requires a new partnership in science and technology--one which brings together the Federal Government, private enterprise, State and local governments, and our universities and research centers in a coordinated, cooperative effort to serve the national interest. (52:2)

The President also specifically expressed his intent to:

> . . . draw more directly on the capabilities of our high technology agencies--the Atomic Energy Commission, the National Aeronautics and Space Administration, and the National Bureau of Standards in the Department of Commerce--in applying research and development to domestic problems. (52:4)

In summary, the President's policy statement calls upon all levels of society, to include government and private enterprise, to work in close cooperation and to assume responsibility for solutions to national problems.

Federal Council for Science and Technology Policy

The Federal Council for Science and Technology (FCST) further amplified the Executive policy for expanded interagency cooperation in the use of Federal laboratories. The policy recommends that existing Federal laboratory capabilities be used instead of creating new or additional capabilities and encourages all agencies to develop appropriate coordinating mechanisms to ensure effective interagency collaboration. (68:1) The FCST suggests some flexibility in manpower ceilings when a Federal facility is asked (by another Federal agency) to accomplish work that is within its competence and when funds are transferred for this purpose. (68:3) As presently construed, these ceilings constitute a major barrier to technology transfer programs. (See Chapter V, VII.) With the exception of the specific provisions relating to manpower ceilings, the FCST policy received a favorable endorsement from the Office of Management and the Budget (OMB). (75:6)

Congressional Policy

Increasing Congressional interest in the subject of technology transfer may have a significant impact on the utilization of DOD developed technology by agencies seeking solutions to the domestic problems of our society. For many years the magnitude of the Federal investment in research and development and the effectiveness of the R&D programs have been subjects of interest and concern to Congress. Congressional activity and inquiry in this area has been constrained somewhat because Congress has lacked access to an independent source of technical expertise with which to perform a critical evaluation of the effort.

Since technology is rapidly changing and expanding, Congress passed the "Technology Assessment Act of 1972" and attempted to pass the "National Science and Priorities Act of 1972," commonly referred to as "S-32." S-32 would authorize the National Science Foundation to investigate technology transfer and determine the most effective means of transitioning from defense R&D activities to civilian-oriented programs. The attitude of the Congress was expressed by Senator Mansfield:

> The matter of science policy has been neglected too long in this country. The science policy of this country has been really determined by who had the money to spend, and the vitality of scientific efforts were determined by that money. It has been to a great extent the DOD and the ease with which it has been able to get resources from Congress that has determined by default the science policy of this country. (38:S13922)

Congressional interest in a centralized Federal technology transfer mechanism is evidence of their desire for a stronger role in Federal R&D policy. (See Appendix A.)

When the 93rd Congress convened, Representative Roush introduced the "Federal Technology Transfer Act." This bill proposes the establishment of an Office for Federal Technology Transfer, which would assume the technology transfer function of the DOD, NASA, AEC, NSF, Department of Commerce, and the Small Business Administration (SBA). This proposal would, in effect, centralize the entire technology transfer program of the Federal government within the Executive branch. (77:4,5)

All indications are that Congressional interest in the technology transfer and utilization programs of the DOD and the separate services will increase. Representative John W. Davis of the House Subcommittee on Science, Research, and Development, expressed to Secretary Melvin Laird his encouragement and support for DOD participation in technology transfer efforts. (18:1) Our legislators are vitally concerned with providing solutions to some of the grave problems of our modern technological society. They see technology as a potential source of these solutions.

Non-DOD Agency Policy

Policy establishing a role for the Federal government in active technology transfer is not new. Land-grant colleges and agricultural experiment stations established in the latter part of the 19th century helped generate technology in the form of improved agricultural techniques and new varieties of products. However, it was not until the creation of the extensive county agent system in 1914 that the new technology was used. The county agents serve as third-party transfer agents between the colleges, experiment stations, and the farmers. "Today the U. S. Agriculture Department's research and extension system is generally considered a leading example in this country of technology generation, transfer, and use." (75:3,4)

Other agencies with explicit legal charters which include the function of technology transfer are the Atomic Energy Commission, the National Science Foundation, and the Small Business Administration. (75:4) The Departments of Commerce, Interior, and Housing and Urban Development have implicit policy with respect to promoting technology utilization. (75:4) Implementation of the National Aeronautics and Space Act resulted in the establishment of the Technology Utilization Program discussed in Chapter IV. (41:22) Still another non-DOD agency in which formalized technology transfer plays an important role is the Atomic Energy Commission. AEC officials consider that transfer of nuclear technology to the public and private sectors for peaceful purposes is their primary mission. (41:22)

Department of Defense Policy

An awareness of the role which DOD could play in helping to find solutions to the nation's urban problems was manifested in 1969. At that time, the Secretary of Defense ". . . established the Domestic Action Council and charged it with the responsibility for discovering and implementing ways to make a greater contribution to solving public problems." (41:21,22) It has not been a successful program. In the estimation of the GAO investigators:

> The Council has been encouraged to seek better methods to apply defense technological advances more rapidly in the civilian economy, but no implementing policies have been recommended because of uncertainty of DOD's role in such activities. (41:22)

Because of this uncertainty and because of the considerable interest in the Congress and other Federal agencies to exploit Defense technology for the solution of domestic problems, Dr. Foster, DDR&E, in coordination with the Assistant Secretaries of the Service Departments, recommended that the Secretary of Defense promulgate policy guidance concerning work for the civil sector being performed in Defense laboratories. (72) To provide this guidance, the Secretary of Defense in August, 1972, sent the Secretaries of the Military Departments, DDR&E, and Assistant Secretary of Defense (Comptroller) a "Memorandum on Non-Defense Work in DOD Laboratories and R&D Facilities." (102)

The policy guidance provided by the Secretary of Defense concerns those efforts separate and distinct from work being done for defense-oriented agencies such as the AEC and NASA. The memorandum endorses the "spirit and intent" of the FCST policy on expanded interagency cooperation.

The memorandum further encourages the military services to participate "consistent with mission and legislative constraints." The actual level of effort is the prerogative of the individual Military Department, which is encouraged to issue more detailed policy guidance. However, the memorandum does restrict these more detailed policies to the following considerations:

1. The level of effort of technology transfer must not impede accomplishment of the mission.

2. The technology transfer projects must be compatible with the technological capability of the laboratory concerned.

3. Projects may support Federal, State, or local government organizations. Projects for the private industrial sector are to be performed only on an exception basis.

4. The full costs of projects will be reimbursed through formal written agreements.

5. Joint programs must have a direct application to a military requirement. The commitment of funds and resources in joint programs must be commensurate with the interest of each of the agencies. (102)

The Memorandum concludes by directing the Assistant Secretary of Defense (Comptroller) to explore with OMB the means for alleviating any imposed manpower constraints which limit DOD participation in technology transfer to non-defense agencies.

The reception of this policy guidance has been favorable. The GAO investigators commented that, "We believe that this statement of policy is an important step forward and, if followed by implementing actions to insure compliance, should result in increasing use of defense technology in solving civil problems." (41:24)

Navy Policy

The Navy moved promptly to endorse the policy of DOD and to formulate policy of its own. The Navy policy encourages the use of active technology transfer techniques, including third-party transfer agents, to identify potential applications of defense technology in the public sector. Their program operates under the premise that the efforts will not compromise the primary mission, and the using agency will reimburse the costs. (50)

The policy also endorses the participation of Navy laboratories in an informal consortium with other DOD laboratories through the use of a transfer agent. (See Chapter IV). Offices of primary responsibility (OPRs) have been created at sub-command level. Thus, by clearly stating a non-ambiguous policy, by specifically designating the OPRs for technology transfer, and by incorporating a transfer agent in the mechanism, the Navy has devised an extremely effective technology transfer program.

Air Force Policy

Unlike the Navy, the Air Force has not issued more detailed policy guidance in response to the Secretary of Defense's memorandum on non-defense work in DOD laboratories. However, in October, 1971, Dr. William Lehmann, Deputy for Laboratories, Office of the Assistant Secretary of the Air Force (R&D), issued a policy statement on Air Force laboratory support to other agencies in order to overcome the reluctance of laboratories to provide such support in the absence of policy guidance. (79:1) Dr. Lehmann's guidance provided that:

1. Air Force laboratories are encouraged to provide information and consultative services to other government agencies.

2. Joint programs are strongly encouraged in areas of mutual interest.

3. Air Force laboratories are encouraged to perform additional efforts which piggyback upon existing programs. The requesting agency must reimburse the

incremental costs. However, the total of such work for non-defense agencies must be limited to 20 percent of the laboratory's total effort.

Dr. Lehmann's letter was transmitted to the laboratories, but had little significant impact. (See Chapter V.)

In the absence of other specific policy guidance, one must turn to Air Force and Air Force Systems Command Regulations to find authorization and guidance for technology transfer. (Appendix B contains a brief summary of applicable regulations.) In essence, the regulations primarily acknowledge the necessity to transfer technology within the Air Force to accomplish the mission.

Analysis of the regulations reveals that the transfer activities discussed are primarily passive in nature. (33:2) Active technology transfer is restricted primarily to attendance at scientific meetings and symposia. Other active transfer mechanisms are not specifically mentioned; therefore, they do not <u>appear</u> to enjoy official sanction.

In December, 1971, the Deputy Director of Laboratories, Headquarters, AFSC, transmitted Dr. Lehmann's policy to the AFSC Laboratory Directors. He encouraged support of the policy, but the tone of the letter of transmittal is such that the support appears weak. (89:1)

Therefore, it seems doubtful that the letter will alleviate reluctance on the part of R&D management.

The predominantly negative attitude of the Director was strongly reinforced by guidance issued by General Brown, Commander, AFSC, in August, 1972. (67:1) General Brown expressed concern about the effect of severe constraints on available dollars and manpower which have forced the cancellation or curtailment of a number of priority efforts. He, therefore, directed that any new relationships contemplated with outside agencies are subject to Command approval. Naturally, one would expect little enthusiasm for technology transfer at the laboratory level in light of such guidance from the Commander. Positive, unequivocal support is necessary if the program is to be effective at all.

Another Systems Command office memorandum which bears upon the subject of technology transfer establishes a mechanism for formal documentation of all support agreements between AFSC laboratories and other military services or government agencies. (73) One might expect this office to be the logical source for information about technology transfer agreements. Several factors mitigate against this, however. First, the office perceives its function to be the maintenance of a file of agreements for reference purposes only. Secondly, although the program covers both services and materiel support, the people who implement the program emphasize the latter and restrict the interpretation of the former to Host-Tenant Agreements. They do not feel that technology transfer agreements fall within their area of responsibility. (See Chapter VI.)

In summary, the existing framework of Air Force Regulations, AFSC Regulations, and policy memoranda could support a potentially excellent technology transfer program within the Air Force. However, strong policy guidance, reflecting a commitment on the part of senior management, is essential to an expanded Air Force role.

CHAPTER IV

PARTICIPATION OF FEDERAL AGENCIES IN TECHNOLOGY TRANSFER

> We are still for the most part accomplishing technology transfer in a patchwork, hit or miss fashion that does not get at the real root of our problems or mobilize the full power of the technology to solve them. (133:1)
>
> Lt. General Schultz

NASA and SBA Participation

Technology transfer functions and programs of various designs have been established in a number of Federal agencies. The programs have generally produced good results in addition to identifying problem areas to be avoided or overcome. Two of the more significant technology transfer programs that have been established are those of NASA and SBA. An evaluation of the nature of their programs, and their relative success is appropriate to this study.

Aviation Week and Space Technology, 25 December 1972, reported on the National Aeronautics and Space Administration's system, the Technology Utilization Program (TUP). Services are handled through seven Regional Dissemination Centers (RDCs) which provide access to NASA technical information abstracts. The abstracts are categorized into 34 different technical areas and placed in NASA's computerized data bank. At present, an estimated one million indexed technical reports are on file. For a nominal fee, the RDCs will conduct a data search in a given technical area.

NASA estimates that only about 2,000 of a possible 300,000 companies per year are being reached by their program. They state that the ban on advertising by Government agencies and departments has been a large handicap. However, one must remember that, first of all, this is a passive program which is dependent upon the user's initiative, and secondly, an unadvertised program takes time to become known. NASA is trying to overcome the lack of exposure through news releases and trade publication articles.

NASA has also initiated active transfer programs on a pilot basis through the use of technology application teams (TATeams). These groups have enjoyed limited success. One source felt that the limiting factor was not related to an inadequate NASA product; rather, the limitation resulted because the NASA teams had to "sell" the technology to the potential users. The source felt that the expense in "selling" the user is too great to warrant a standing program which requires extensive "beating the bushes" for potential users, followed by a concentrated program of nuturing the project to success. This is not a criticism of NASA's efforts; however, a solution looking for a problem to solve is not an efficient method of active technology transfer. (86) Problems generally require specific solutions for a specific situation.

The Small Business Administration established the Technology Utilization (TU) program in 1967. They have been operating with three people in their Washington headquarters and ten engineering personnel in the field. (135:1) Mr. Forrest S. Decker, Chief, Technology Utilization Division, explained that the SBA program is both a passive and an active system. (115) On the passive side, the TU Division generates monthly brochures containing information on NASA technology entitled <u>Current Index of Technical Briefs</u>. The brochure contains very brief abstract descriptions outlining the purpose of the various reports. The abstracts are arranged according to major product areas (e.g., computers, food, instrumentation, etc.). A reader response card, addressed to NASA, is attached to the brochure. SBA sends the <u>Index of Tech Briefs</u> to approximately 35,000 small businesses each month, using addresses categorized by Dunn and Bradstreet's Standard Industry Classification (SIC) numbers. (115;135:1) Response has been excellent, primarily because businesses of a small nature can use the help, and the proper businesses for each Index of Tech Briefs are reached through use of SIC numbers rather than general mailings. Of 145,000 industrial concerns contacted since 1971, 22,975 concerns submitted requests for 52,659 technical reports related to the Index of Tech Briefs abstracts. (135:2)

During the same period, SBA received requests for help on other technical problems. The active transfer program, through the field agents, involved finding technical information to solve small businesses' problems. Assistance was provided in solving 6,614 technical problems. (135:2) Mr. Decker explained that since the SBA does not have any "in-house" technology, their active transfer function consists of the field personnel's efforts to locate the appropriate technical information or the proper technical contact. When technical reports will satisfy the user's requirement, SBA either forwards the information directly to the client or tells him the location of the source. Other SBA sources of technical data are the National Science Foundation, the National

Bureau of Standards, the Navy's Government-Industry Data Exchange Program, the Environmental Protection Agency, and the Atomic Energy Commission. The field representatives also depend on their ability to locate via telephone personal contacts who can assist clients with their problems. Mr. Decker emphasized that passive transfer through technical data dissemination, although important, is not enough to do the complete job. He stated that problem-solving through an active process has to be the prime mover for successful technology transfer. (115) Several of the pilot transfer programs have also indicated that transfer agents are essential to an effective program.

DOD Participation

The formal use of technology transfer from DOD to the civil sector for the solution of domestic problems began at the Naval Weapons Center (NWC), China Lake, California, in May of 1970. The initial efforts were chosen for rapid payoffs. In other words, programs were selected which required minimal adaptive engineering to accomplish the transfer to civil agencies. With the aid of a contractor third-party transfer agent (Perrin Associates), who coupled the users' problems with NWC developed technology, the Center formed a technology utilization office (TUO) in March, 1971. The purpose of the TUO was to coordinate technology transfer activities and to promote discussions between the NWC engineers and the potential users. Some of their cooperative programs are listed below:

1. Firefighting system for STOL airports (offshoot of aircraft carrier firefighting program with the FAA (DOT)--$200K.

2. Participation in warm fog clearing program with the FAA--$50K.

3. Use of NWC's mobile monitoring equipment for three dimensional mapping of pollutants in major portions of the South Coast, the San Francisco Bay Area, and the San Joaquin Valley air basin with the State of California--$85K. (92:5,6,7)

Acting on a suggestion from Mr. Ed Glass (Assistant Director of DDR&E--Laboratory Management), the Naval Weapons Center presented the results of their technology transfer programs to various DOD laboratories. The formation of a consortium of DOD laboratories for the purpose of adapting defense technology for the solution of domestic problems was suggested by NWC.

In July, 1971, further discussions on DOD/civil sector technology transfer were held between representatives of eleven laboratories. Although the major objective of the original consortium was to transfer DOD technology to civil agencies, the attendees concluded that the consortium would also improve the flow of information and technology between laboratories. Beneficial joint programs would result. The uniqueness and similarities of the various DOD laboratories would become known to each other, thus fostering cooperation in mission-related R&D projects.

As a result of increased interest (at least at the DDR&E level), the NWC and the NSF jointly funded a technology transfer agent, Mr. Harold Metcalf, to facilitate the process of coupling needed DOD technology to the civil sector. Mr. Metcalf joined the staff of the NSF in September, 1971, on a one-year experimental basis, working under the direction of Dr. Frank Hersman, Head of Intergovernmental Science Programs.

When Ed Glass retired in late 1971, Navy Captain Gordon Smith, special assistant to Dr. Gus Dorough, the Deputy Director of Research and Advanced Technology, became the focal point for DOD technology transfer.

At the second meeting of the consortium in December, 1971, Captain Smith stated that the DOD program was concerned with four main types of technology transfer:

1. Direct transfer to the civil sector (no adaptive engineering required).

2. Transfer requiring adaptive engineering.

3. The use of basic DOD technology and facilities to transfer new developments to the civil sector.

4. Aid the establishment of specific competences in the civil agencies. (139:2)

Captain Smith and Mr. Metcalf, the technology broker for the consortium, have determined that several Federal agencies desire cooperative interaction with DOD laboratories. Representatives of the following organizations have explained their functions, programs, and technology needs at the various meetings of the DOD consortium: Office of Intergovernmental Science Program, RANN, National Oceanic and Atmospheric Administration, Environmental Protection Agency, Small Business Administration, Law Enforcement Assistance Administration, Office of Civilian Defense, Public Technology Incorporated, National Bureau of Standards, National Technical Information Service, Massachusetts Technology Exchange, AEC's Technology Utilization Office, National Heart and Lung Institute, Federal Highway Administration, Jet Propulsion Laboratory, NASA Technology Transfer Program, Stanford Research Institute (NASA-TATeam), Aerospace Corporation, and the National Institute of Law Enforcement and Criminal Justice.

Through the informal liaison of Captain Smith and Mr. Metcalf with NSF, DOD laboratories, and civil agencies, the DOD consortium has expanded to 22 laboratories/centers and 10 million dollars worth of reimbursable business, covering over 50 projects funded by 13 different agencies. (93:13)

Since its inception, four meetings of the consortium have been held during which the topics of progress, problems, solutions, and future directions have received considerable attention. Based on the experience of the Naval Weapons Center with other Federal agencies, and State and local governments, the most successful programs have been in the area of cooperative development. Thus, NWC has increased its efforts in obtaining joint programs which begin small but have the potential for continued work in the future. (93:3)

Recently, the DOD consortium drafted an operating policy stressing voluntary membership and participation by DOD laboratories. Emphasis was placed on a low-key technology transfer program. (96:1,2) Although the NSF/DOD consortium transfer agent has been very successful in determining civil agencies' needs, the fear of the Mansfield amendment (that programs must be directly related to the defense mission) was a retardant in the initial stages of the technology transfer process. Despite the use of reimbursable monies from civil agencies, the hiring freezes and the limited availability of manpower became the major drawbacks.

Necessarily, Captain Smith has urged the Office of the Secretary of Defense (Comptroller) to provide relief from the civilian manpower constraints.(140:1) As of 7 August 1972, civilian manpower ceilings in the military services were removed by the Comptroller. (88) The manpower limitations, however, still appear to be the major barrier to not only the reimbursable programs of technology transfer but to the R&D mission-related work as well. The dilemma of manpower ceilings and possible alternatives to accomplish both defense and non-defense projects will be discussed in depth in Chapters V and VII.

Participation in the DOD consortium has been dominated by the Navy laboratories and centers. Undoubtedly, a major reason for the extensive Navy role in the technology transfer consortium has been the support of their top-level management, including the Secretary of the Navy. The Chief of Naval Material has designated Rear Admiral T. D. Davies, Deputy Chief of Naval Material/Development, as the Navy's Director of Military-Civilian Technology Transfer and Cooperative Development. (93:11) His initial instructions directed the designation of a part-or full-time technology transfer representative at each facility. These representatives are charged with the task of locating potential non-military technologies (not developing new technology) for the civil sector with strong emphasis on involving contractors whenever possible. (140:1) The other role of the technology transfer agent is public relations; that is, the presentation of more promising items via the news or television media. A Navy plan for technology transfer or cooperative development has been drafted into instruction form and is awaiting action by the Technology Transfer Director (the Navy policies were treated in Chapter III).

Of the four Air Force organizations listed as members of the consortium, only Rome Air Development Center (RADC) and Air Force Rocket Propulsion Laboratory (AFRPL) attend consortium meetings. Only AFRPL has any formal civil agency programs. The Air Force Weapons Laboratory (AFWL) and Cambridge Research Laboratory (AFCRL) are inactive at present.

The Army has also offered a modicum of support to the technology transfer consortium, although four laboratories have been involved in consortium meetings. High-level Army opinion feels secure in the idea that "the Army has made significant contributions to technology transfer," primarily in the field of its Corps of Engineers public works projects. In a letter of response to a draft of the GAO report (41), the Army spokesman suggested that:

> . . . emphasis . . . placed on the "active" method of technology transfer may be misdirected in light of the Army's "participating" contribution. Even a well designed and dynamic program of "passive" technology transfer can contribute much to relating potentially relevant defense technology to interested and potential users in federal civil agencies. (98:2)

Further reaction from the Army is not expected unless additional guidance of a more directive nature is forthcoming.

Although the Air Force formal role in the DOD consortium is minimal, the authors are aware of several Air Force programs supporting other agencies. The assessment of the current level of Air Force participation in interagency work is given in the section below.

Air Force Support of Interagency Programs

The search for the degree of Air Force science and

and technology/R&D capability being used to support the needs of other DOD components, non-defense agencies, Federal civil agencies, and State/local governments was complicated by the wide dispersal of such information in many different offices at Headquarters AFSC, the obvious absence of data from some of the offices, and the time limitations. Although numerous interagency programs were identified, the magnitude of support to other agencies in terms of funds and manyears could not be determined. However, the examples contained in Appendix C serve to illustrate that technology transfer to organizations outside the Air Force is occurring at the laboratory/center level.

Most of the information on the cooperative and supportive programs of Air Force laboratories/centers was obtained from the monthly laboratory activity reports. Active efforts are concentrated in the areas of civilian aviation and environmental protection, as might be expected. Based on close scrutiny of 133 potentially transferrable activities listed in laboratory activity reports, it became apparent that many of these items were not being actively transferred; that is to say, many of the technological developments contained in the reports (equipment, device, material, process improvements, etc.) only represented the potential for non-military applications and merely suggested areas of possible interest to civil agencies or the civilian economy. In 1971, the Air Force signed an interagency agreement with the Small Business Administration for the expressed purpose of transferring AF technology to the small business private sector. According to officials from the Technology Utilization Division of SBA, they have received a half a dozen or so inputs from the Air Force, all written in a style that was too technical to be useful to small businesses. (115) The message is crystal clear: Air Force technology transfer is occurring on an ad hoc basis rather than a systematic one. The reasons for the relatively unstructured, passive approach of the Air Force's technology transfer to other agencies is covered in depth in the following chapter.

Another conclusion that emanates from this investigation is that the Air Force is obviously <u>not capitalizing</u> on the degree of its current support to outside agencies. This perception is amplified by the belief as expressed in the GAO report and the DDR&E(R&AT) office that the Air Force's involvement with technology transfer for non-defense needs is virtually non-existent. The causes for the unawareness of Air Force technology transfer efforts are presented in Chapter VI.

CHAPTER V

ADVANTAGES AND BARRIERS TO EXPANDED AIR FORCE PARTICIPATION IN TECHNOLOGY TRANSFER

> Transferring technology may be rationalized as self-preservation. As the war in Vietnam winds down, it is in our self interest to investigate what we can do other than make missiles. (13:1)
>
> Dr. Walter LaBerge, Naval Weapons Center

Previous chapters have examined the various layers of policy which relate to participation in active technology transfer programs and the extent of current technology transfer efforts. Since Air Force involvement has been shown to be both legitimate and feasible, this chapter will address the advantages of and the barriers to expanded Air Force participation.

Advantages

The advantages which will accrue to the Air Force by increased efforts in technology transfer to the civil sector are many and varied; however, they can be generally classified into two broad categories: those programs which enhance defense mission effectiveness and those which make a positive contribution to the solution of the problems which face society. These two classifications include numerous projects which offer both tangible and intangible advantages. The advantages and the supporting rationale are discussed in the following paragraphs.

To complicate the issue, the first advantage proposed fits neither category. If the Air Force does not establish a realistic and effective technology transfer program on its own, Congress or the Department of Defense may impose a system that could well prove cumbersome and ineffective within the present organizational framework of AFSC. The recent experience with the Technology Coordinating Papers (TCPs) devised by Dr. Foster is illustrative of the type of problem which can result (see Chapter IV). The TCP's are planning documents to help DDR&E assess the research, exploratory, and advanced development programs and goals in the various technology areas of the Defense Department's responsibility. (14:14) Although the guidance was very clear, the Air Force was reluctant to comply with DDR&E's request. The response was rapid and sincere when the Air Force learned that program funding was contingent upon acceptance of the TCP concept. The hand writing is on the wall again; Congress, the Administration, and DDR&E are interested in technology transfer. Hopefully, the Air Force will become more interested in technology transfer.

Enhanced Mission Effectiveness

Reduced Cost. No coercion is needed to get Air Force attention on the subject of appropriations. Perhaps the most significant, direct, and easily defended advantage is found in the area of reduced costs. The GAO report states, "An increase in technology transfer is an important step in achieving maximum return on the nation's investment of billions of dollars." This cost-effective approach offers the potential for avoiding duplication of effort, stimulating the national economy, and strengthening the international trade balance. (41:5) In addition, Dr. George M. Low, Deputy Administrator of NASA, made the observation that one way to reduce costs is, "Don't reinvent the wheel. Use the best technology that is available from other programs." (17:9) In other words, the improved communications network and integrated Federal R&D base which will result by establishing channels for information flow and technology transfer will work both ways. Such a network may provide unique and unforeseen solutions to Air Force problems from defense and non-defense Federal agencies.

Technology Base. Closely related to cost is the impact of reduced financial support and associated manpower reductions on the Air Force Laboratory system. This impact usually manifests itself as either an across the board percentage reduction, the elimination of lower priority programs and associated manpower, or a combination of both. The result is invariably reduced capability far in excess of the size of the reduction itself, because the technology base has been reduced. Certain skills and expertise are, of necessity, lost since there is no way to mothball scientific capability until the return of more prosperous times. Rapid mobilization of scientific and engineering talent is difficult. The logical question becomes: Why should the Air Force and DOD maintain an extensive scientific and engineering resource base? One only has to analyze the effect of the SALT I agreements on the research and development plans of the Soviet Union to find the answer. As pointed out in Chapter II, at their present level of effort (which exceeds ours by forty to fifty percent), the USSR will surpass us in total defense capability somewhere between 1975 and 1978.

The challenge is formidible and uncompromising! How do we maintain our strategic deterrent capability in the face of increasing manpower and hardware costs with the prospect of no increases in the purchasing power of future budgets? Dr. Foster clearly outlines our objectives:

> We must reduce the cost of acquiring weapon systems by thirty percent, or about $7 billion a year, and we must do it without sacrificing technical excellence and without compromising the performance capabilities needed for military missions. We are doing this by reorienting our design and acquisition process toward greater productivity through what we call our "design to cost" philosophy. We must reduce dramatically the cost of owning and operating capable systems. (22:58)

This design and procurement scheme for new systems is aimed directly at cost-effectiveness and the concept of diminishing returns; the goal is to establish comprehensive life-cycle costs that reflect the lowest possible price for which a specified level of performance can be bought. This policy of cost ceilings does not mean that the Air Force is willing to accept less quality of technological excellence in the final product. Dr. Foster admits that this approach assumes a commitment to accept higher costs in time and dollars in the research and development phase. (22:59)

Thus, the necessity to maintain a broad and sophisticated technological base to support new weapons acquisition development calls for better management practices in the government and industry, and more emphasis on joint efforts between the AF, DOD, NASA, and the commercial sector.

Despite the advent of prototyping, an earlier test and evaluation cycle, better budget control procedures, and overall, more disciplined management, the costs of increasingly complex hardware will remain high and could seriously impact on the funds available for the technology base (6.1, 6.2, 6.3 non-systems funds). At the current and projected defense funding levels, the occurrence of technology gaps and the possibility of technological breakthroughs by our adversaries becomes increasingly plausible. The comparison of our FY 74 defense budget to FY 64 (which was $8.7 billion greater) in terms of constant dollars further erodes our confidence in the protective capability for our technology base. (See Appendix F.)

Necessarily, one of the purposes of DOD laboratories is to "provide a technological capability for quick response to unpredictable needs and opportunity." (37) The retention of specially trained scientific and engineering talent to guard against technological contingencies is somewhat analogous to the Air Force practice of utilizing pilots in non-flying assignments to provide a rapid, credible response to wartime build-ups. In fact, the weakening of our technology base resulting from loss of the scientific and engineering (S&E) manpower resource could have far more serious consequences. More active participation of the Air Force laboratories/centers in both defense-related and non-defense joint technology transfer programs could help sustain the capable and responsive technology base necessary to react to unpredictable demands and threats. An ancillary benefit is to be realized in that reimbursable programs broaden the financial base and reduce the impact of fluctuations in DOD research and development funding. This is similar to the major goal of diversification programs on the part of industry. (45:6)

One researcher proposes an extensive plan of diversification in which the laboratories would perform market research, assess their own capabilities, and submit proposals to obtain outside work. His plan would achieve these objectives:

1. Permit the laboratories to advance the state-of-the-art in areas critical to defense.

2. Make significant contributions outside the defense community.

3. Provide means for professional staff members

of laboratories to contribute to solutions of other urgent unsolved social problems that face the nation. (46:3) Although this plan has merit and appeal, the authors believe it is a bit too extreme. One of the proposed guidelines expressed in the GAO report reads, "DOD personnel should be instructed to refrain from aggressive promotion that might be construed as an attempt to proliferate a DOD resource element no longer needed in the defense program." (41:44) Therefore, the Air Force program should be designed to achieve the stated objectives, yet retain a low profile.

Serve the National Interest

Satisfy Needs. The second and third objectives mentioned above relate to the second broad category of advantages--solution of societal problems. By encouraging technology transfer, the Air Force can help satisfy the domestic needs of the American people and can appeal to the younger members of our society who share concern for the domestic welfare of the nation. In light of the anti-military attitude of the younger generation and the increased competition for military personnel generated by an all volunteer force concept, a technology transfer program to the civil sector could be conducive to recruiting additional qualified members of this group. This development would reduce the age and grade imbalance of the Air Force civilian scientific and engineering force, offering a significant alternative to the dilemma of growing scientific manpower shortages and rising costs (compromised technology base).

Improved Air Force Image. Air Force Regulation 80-3 requires that laboratory directors "take advantage of opportunities for greater prestige by publicizing the significant work of individual scientists and engineers." Publicity about the efforts of Air Force R&D to address non-defense problems should improve the Air Force image at a time when such improvement is sorely needed. In addition to enhancing the recruiting capability of the Air Force, a more favorable image with the American public can only have a beneficial effect on the Congress when Air Force budget requests face critical Congressional review.

Stimulate Economy. Finally, as the Air Force technology transfer program becomes truly functional and as Federal civil agencies establish the mechanisms necessary to take advantage of the technology, non-defense markets could evolve with a favorable impact on employment, the domestic economy, and the international trade balance. (41:12)

When one considers the potential benefits to the Air Force which can be realized by expanded participation in an active technology transfer program, it becomes clear that it is definitely in the Air Force self-interest to become more deeply involved. Unfortunately, simply becoming convinced is not enough. Positive action and commitment are essential to overcome all the barriers to an expanded Air Force technology transfer program.

Barriers

The implementation of an expanded Air Force technology transfer program depends more on the barriers than on the advantages. The barriers to technology transfer can be separated into two basic types: Those factors which are obstacles to the acceptance of an expanded, formalized technology transfer program within the Air Force (the most important barrier), and those factors which affect the transfer of information itself--the obstacles to the effective use of transfer mechanisms. The mechanistic barriers of the transfer process will be treated first by way of illustration.

Barriers to Transfer Mechanisms. An example of this type of barrier is found in the broad category of communication. "The capability and resourcefulness of technology developers and potential users to recognize prospective applications of technology to areas other than originally intended is one of the most significant factors in technology transfer."(41:6)

Bypassing a discourse on patterns of recognition and innovative thinking, and assuming that the technology developer and the user have the ability to match the technology with the need, the problem focuses clearly on communication. At present, the laboratories do not understand what is needed by the civil sector, and the civil sector is unable to express its requirements to potential Federal laboratory sources. (87:3) This communication problem is aggravated by a lack of common terminology which has been and will continue to be an inhibiting factor in channeling DOD-developed technology into the civilian community. (98:1) The communication which must flow between developer and user must be precise enough to state the actual problem. In the case of State and local governments, the administrators concerned are not "particularly accustomed to formulating their needs in technical terms at a level of specificity to which highly technical engineers might relate." (59:iii) The problem/solution process thus suffers since the two are not on a specifically compatible level; solutions may be proposed for the wrong problem!

Barriers to Acceptance of Transfer Programs. As stated earlier, this type of obstacle is of greater concern to this study. Barriers which inhibit the acceptance of technology transfer programs, *per se*, may be classified as either real constraints or perceived constraints. To be sure, a perceived constraint is real enough to the one who perceives it, but that distinction is ignored in this treatment. Examples of real constraints are: (1) legal, to include financial; (2) competition with the private sector; and (3) limited resources, to include manpower ceilings. Perceived constraints include: (1) lack of policy guidance; (2) decreasing Administration impetus; (3) public non-acceptance through ignorance; (4) fear of Congressional censure; (5) inability to measure effectiveness; (6) lack of incentives, to include markets; (7) inferior, untimely work; and (8) manpower ceilings. The fact that manpower ceilings appears as both a real and a perceived constraint further emphasizes its importance which will be discussed in detail later (Chapter VII).

Real Constraints

Legal. The legal blockages to technology transfer programs encompass the various rules, regulations, and laws which affect both government-financed R&D and privately developed technology. For example, a small business firm that considers manufacturing a new product may be inhibited by the patent laws. If the business does not have the available funds to purchase the patent rights to privately developed technology, or if the patent holder is unwilling to allow licensing, then the firm is unable to acquire the necessary technology. On the other hand, if the technology was developed with public funds, the patent rights are generally available to all. Therefore, if the firm's production and marketing efforts prove successful, it has no protection under the law for the product. (21:9) To help remedy this situation, in August 1971, the Administration liberalized the private use of government-owned patents, and directed that they be made available to private firms through exclusive licenses where needed to encourage commercial application. (52:5)

Another real obstacle involves the restrictions placed upon the expenditure of public funds by law. These restrictions are of particular importance to the consideration of technology transfer from Department of Defense laboratories to non-DOD parties. In the past, many DOD laboratories did, indeed, carry on limited amounts of research and development having little, if any, military application. (46:8) However, "recent legislation precluding the expenditure of defense research and development funds for other than mission-related projects has tended to raise concern within DOD as to the role it should pursue in technology transfer for civil use." (41:23) The Military Procurement Authorization Act, Public Law 91-121, Section 203, as amended (Mansfield Amendment), states, "None of the funds authorized to be appropriated by this act may be used to carry out any research project unless such project or study has a direct and apparent relationship to a specific military function or operation." (57) Shortly after passage of the Mansfield Amendment, Deputy Secretary of Defense Packard sent out the following instructions:

> Any DOD funded project which does not have a direct and apparent relationship to a specific military function or operation must be terminated in an orderly way as soon as possible. . . . In summary, addressees are requested to take all necessary actions, beginning immediately, to comply fully and scrupulously with the law. Under no circumstances shall the Department support work which does not have a direct, apparent, and clearly documented relationship to one or more specifically identified military functions or operations. (97)

The 1971 Department of Defense Procurement Act, Public

Law 91-441, relaxed this hard-line posture somewhat by authorizing the expenditure of such funds to those research projects or studies which have "in the opinion of the Secretary of Defense, a potential relationship to a military function or operation." (41:23) It should be noted that neither the legislation nor the DOD guidance places any restriction upon the performance of non-defense-related work or the transfer of technology if the funds are provided by outside agencies. The GAO report supports this contention by concluding that:

> . . . although legislative clarification delineating DOD's role might be desireable, it is appropriate within existing statutory limitations for DOD to encourage active transfer to make its technological resources available to civil agencies to an extent that does not interfere with the defense mission. (41:24)

Another aspect of legal constraint involves the processes of providing funds from one agency to another. Federal agencies performing services for each other present little difficulty, since funds can be transferred with relative ease. However, if a Federal laboratory performs services to a State or local government, payment must be made to the United States Treasury. (87:1) Additional problems are then encountered in reimbursing the laboratory. Of course, these additional problems can be overcome or circumvented by one means or another.

One such means involves the use of NSF funds. In April, 1972, President Nixon granted the authority to the Director, NSF, to fund research relevant to national problems involving the public interest at institutions (such as DOD laboratories) other than academic and non-profit institutions when it is advantageous to use the capabilities of the other institutions. (130) Another proposal uses the authority of the Intergovernmental Cooperation Act, which provides means for moving Federal laboratory employees into the employ of State governments. These persons could remain resident in the Federal laboratories with access to a technical base far superior to that available to the State agency and perform needed research for the State while on the State payroll. In essence, Federal manpower is dedicated to a State or local government effort with funding provided by the outside agency. Such a solution might be particularly appropriate to support a long term, relatively constant level of effort. However, problems remain. Who pays for the overhead costs, etc.?

<u>Competition</u>. Fear of competition with the private sector in providing solutions to public problems comprises the second real obstacle to expanded Air Force participation in technology transfer. It is a basic

premise that the government should not compete with industry in either R&D or production. Only when industry lacks the capability, is unprepared to assume the risk associated with a new technology, or is otherwise unwilling to perform in a given area should the government become involved. At present, the Federal laboratories have no blanket criteria for solving the problem of potential competition with the private sector. However, certain laboratories have rendered clear policy decisions not to engage in any work if there is any likelihood or indication that private sector capability exists. (87:3) The authors concur with this viewpoint. Air Force endeavors in the support of technology transfer should be restricted to instances when Air Force laboratory support is specifically requested, necessary technical expertise exists in the laboratory, and the laboratory possesses a unique capability in the area.

Scarce Resources. The additional demand placed on already scarce resources creates the third major real blockage. Both physical facilities (such as laboratory space, equipment, etc.) and manpower are considered to be scarce resources. Performance of the primary DOD and Air Force missions is enough to keep the staffs fully occupied and to tax the facilities. (40:1)

Mr. Alfred J. Eggers, Jr., National Science Foundation, Programming Office, made the following comment in reference to the RANN program: ". . . some opportunities for utilizing . . . Federal laboratories were negated due to manpower limitations, and future opportunities would be enhanced if these limitations were eased." (70) Dr. Foster stated:

> The extent of the adaptive engineering work performed by the Defense laboratories for technology transfer is limited by the availability of technical manpower at our research and development laboratories. Only with additional manpower resources can there be a significant increase in the amount of work performed for the civil agencies without interfering with the primary mission of these laboratories. (41:51)

Dr. Foster also revealed that DOD was planning to address the management problems associated with carrying additional laboratory staff funded by non-DOD sources. overall impact of manpower shortages and ceilings wi be discussed later. (See Chapter VII.)

Perceived Constraints

The real obstacles confronting technology transfer programs are formidible. Yet, progress is impeded even more by a multitude of perceived constraints, some of which were enumerated earlier. They are perceived, rather than real, to the extent that they result from attitudes and opinions rather than from policy and prescribed procedure. In fact, one of the principle perceived constraints is an apparent lack of policy guidance itself.

Lack of Policy Guidance. The immobile nature of a bureaucracy tends to stifle innovative and imaginative thinking. (3:262) Unfortunately, many people interpret rules and regulations as guidelines to what cannot be done rather than to what can be done. A corollary effect also persists: if no written guidance can be found to justify an action, then inaction results. The management of Air Force research and development efforts does not consider the broad policy statements, regulations, and memoranda of intent, discussed in Chapter III, to be serious and definitive commitments to technology transfer on the part of the Defense Department. Thus, the Air Force has not promoted technology transfer.

A recent meeting of laboratory heads with the Council of State Governments resulted in the observation that "Policy statements at Secretary or Assistant Secretary level do not seem to carry much weight." (87:1) They feel that the policy that does exist is fragmented and is the result of sporadic response to imposed conditions. Dr. Hersman concludes that "No coherent national policy has emerged for deriving the maximum possible benefits from the technological innovations produced by Federally funded research and development, particularly in bettering the social, economic, and environmental aspects of national life." (75:1) The GAO report considers this lack of policy guidance as one of the major barriers to be overcome before more extensive DOD participation will result. (41:21)

Relative to the problems associated with policy or the lack of it, is the wide variance and inconsistency in the degree of authority that the different Federal laboratories have for conducting R&D for other agencies. The perception that results is that present policies are ambiguous and are always subject to reversal, thereby making the laboratory vulnerable to considerable embarrassment resulting from failure to fulfill obligations to the customer. Since Federal laboratories cannot be sued for breach of contract, other Federal, State, or local government agencies have little recourse if and when a policy change or manpower cut endanger the conduct of work performed on their programs. (87:1,4)

Decreasing Administration Impetus. As a consequence of DOD policy guidance not being translated into firm directives to the Air Force laboratories/centers, many managers perceive that the impetus for technology transfer is decreasing. The authors' personal contacts in the field have revealed that many of the R&D managers are aware of the policy statements relative to technology transfer. However, they do not seem to be sold on the merits of such an effort, and firmly believe that emphasis from senior management is transitory and will eventually wither away. Unfortunately, recent events only tend to support this hypothesis.

In March, 1973, Business Week magazine reported on the future of the technology incentives effort which resulted from President Nixon's message of the previous March. When the effort was initiated, industry felt that it was only a fraction of what was needed, but as they saw it, it was a beginning. Now they feel that even that modest effort has stalled. For example, by the fall of 1972, a task force from the Office of Science and Technology and the Vice-President's Office of Intergovernmental Relations had planned to be in operation. Instead, it has all but disbanded. Representative John W. Davis, Chairman of the House Subcommittee on Science, Research, and Development stated, "I was reading over that message the other day, and it was sure full of bright hopes." He said that since then the President has reversed himself. Dr. Michael Michaelis of Arthur D. Little, Inc., commented, "I get the impression the White House is soft-pedaling this whole issue." Business Week believes that the Administration has backed away from the ideas outlined in the President's message for several reasons. One is the growing belief among officials that fostering R&D in lagging industries will take too long to ease current balance of payment problems. Another is that unemployment among scientists and engineers, which was high at the time of the message, has declined sharply. But the toughest blow was the resignations of key administration personnel close to the effort. (25:36) In summary, many people in the R&D community have looked upon the President's program as a national palliative--sort of a domestic Apollo program that is destined to never get off the launch pad.

Public Unacceptance. The impact of the constraint which results from general public unacceptance of technology transfer is difficult to assess, although there is no doubt that public attitudes often raise barriers very difficult to surmount. The fate of the ill-starred super-sonic transport program (SST) and the emotional reaction against the wide-spread acceptance of nuclear power are illustrative of this phenomenon. Mr. William

Magruder, while serving as a Special Assistant to the President, pointed out that the cancellation of the SST program (brought about by the value judgements of an ill-informed public and Congress--authors) was the first "divorce" in a previously happy and mutually beneficial marriage between government and the aviation industry. (128) The divorce is unfortunate for several reasons. For one, the SST was more of an advanced development program to demonstrate new technology and advance the state-of-the-art than it was a commercial venture. Considering that the cost of terminating the program (in excess of 100 million dollars) was greater than the cost of completing that phase of it, the technology to be gained (and which was directly transferrable) was literally thrown away. Secondly, the commercial aviation manufacturing industry in the United States is a major contributer to economic growth and accounts for approximately nine percent of total annual export sales. The results of the cancellation of the SST on this potential overseas market have been disasterous. For the first time, the United States finds itself in the role of follower rather than leader. Hopefully, cooler heads will prevail in future controversies of this type and the trend can be reversed.

Certainly a reversal in attitudes is needed to lessen the impact of an energy crisis in this country. As this study is being prepared, the subject of "energy crisis" is receiving national attention. Mr. James Andover, reporting in the IEEE Spectrum, March, 1973, states that a national power crisis could result due to the delay in construction and licensing of nuclear power plants caused by "technical and safety problems associated with reactors, and environmental considerations resulting from changing social attitudes." (6:72) In the same vein, a power industry expert commented, "If an electric power crisis were imminent, it would be due to ill-conceived environmental regulations and to start-up delays [of nuclear power plants] caused by a handful of well organized but poorly informed people." (6:73) The answer, then, may lie in utilization of third-party transfer agents to help explain the benefits of technology and clear up misconceptions on the part of State and local governments and citizens groups. Dr. Edward Teller, nuclear physicist and Nobel Laureate, believes that the opposition of environmentalists to technological progress will resolve itself--"as soon as America has its first blackout." (6:73)

The Air Force could minimize this barrier of public unacceptance to certain system developments by transferring its advanced technology for the benefits of the public sector whenever possible. The transfer of Air Force MHD (magnetohydrodynamics) technology for the eventual development of commercial power plants serves as an excellent example. The MHD power generation program also represents the optimum in cooperative technology transfer between Air Force laboratories, small business, and a Federal civil agency (Department of Interior, Office of Coal Research--see Appendix E).

Fear of Congressional Censure. Still another perceived constraint can be attributed to fear of possible Congressional censure. Mr. Charles A. Johnson of Perrin-Johnson, Inc., who served under contract to the Naval Weapons Center as a third-party transfer agent, discussed technology transfer with high level personnel in Headquarters USAF during the course of his research. In his opinion, there is "fear of the Mansfields and Proxmires--this is the single over-riding problem. Thus any technology transfer efforts must keep a low profile until and unless Congressional hearings and/or other actions 'bless' their efforts." (124:2) This problem must be confronted directly and resolved, or it will continue to plague any attempt to expand Air Force participation in an active technology transfer program.

Other Constraints. The inability to measure effectiveness, lack of incentives, and inferior work not performed in a timely manner are relatively minor but still significant additional constraints. The measurement of effectiveness or merit of a research and development laboratory's performance is a topic which has been debated by scientists, engineers, and R&D managers throughout industry and government and has yet to be resolved. Two separate issues are of importance here. First, certain high level Air Force managers are concerned about the possible detrimental effect of increased involvement with technology transfer on mission performance. Priority mission-oriented programs could suffer from a dilution of effort. Tight management control will prevent this from becoming a problem. Second, the leaders express concern about the productivity of the transfer effort itself. Fortunately, a more definitive evaluation criterion exists: the degree of satisfaction of the paying customer. Although effectiveness is difficult to assess, the proper mix of defense-related and interagency support programs coupled with effective management practices could enhance the laboratory's overall productivity.

Another barrier which is present throughout the DOD laboratory system is the failure of many managers, scientists, and engineers to appreciate the advantages to be gained from technology transfer. Lacking this appreciation, they also lack incentives to participate. (This subject is discussed further in Chapter VI.)

When people lack incentives and motivation, they often perform poorly or not at all. Some outside agencies, which have attempted to utilize DOD laboratory support to obtain solutions to their problems have experienced delays, complained about inferior work, and have been less than satisfied. A record of poor performance reflects upon the entire laboratory system and affects the accomplishment of the mission. Although these are relatively minor constraints, they are roadblocks to acceptance which must be addressed by any proposed technology transfer effort.

Manpower Ceilings. As significant as the preceeding constraints may be, they become pale by comparison to the barrier imposed by manpower ceiling limitations. Manpower limitations are a real constraint, since cases have been documented in which work for non-DOD agencies had to be refused because the technological facility could not devote manpower resources to the problem. (85:2)

Manpower ceilings also become a perceived constraint when the <u>implied</u> threat of personnel ceiling reductions exists. Both the documentary material and the personal contacts consulted in the course of this study revealed that the perception of implied manpower cuts is the biggest single obstacle to widespread acceptance of expanded technology transfer efforts. H. G. Wilson, Technical Director of the Naval Weapons Center commented in March, 1971, "One deterrent to our doing this kind of work [technology transfer] has been the billet ceiling." (18:3)

The GAO report deals with this problem at length. The report summarizes DOD's perception as follows:

> According to DOD officials, limitations on civilian personnel employment ceilings and, in particular, the <u>threat</u> of reductions in authorized ceilings from one year to the next constituted a major blockage in inhibiting research and development centers from assigning scientists and engineers to nondefense interagency support. (41:25)

The personnel ceilings are imposed by the Office of Management and Budget, which has the responsibility to prepare and administer the Government's annual budget and to develop coordinating mechanisms to implement Government activities, including scientific and technological programs. (41:6) OMB explains the administration of personnel ceilings:

> Under the existing system, the Office of Management and Budget establishes employment ceilings on behalf of the President only at the departmental or independent agency level. Internal personnel allocation among an agency's various programs, activities and installations is determined (or delegated) by the agency head. . . . ceilings are established only for June 30 of each year for full-time permanent and total agency employment. (41:25)

The problem stems from the fact that R&D managers throughout DOD are concerned that "when the end of the year count is made, personnel assigned even on a temporary and reimbrusable basis to non-defense work may be considered non-essential and excluded from ceilings projected for the next year." (41:25)

This concern is not unfounded. Dr. Lehmann's memorandum authorizing the dedication of up to 20 percent of a laboratory's total effort to non-defense programs created quite a stir in Headquarters USAF. At the laboratory level, management interpreted the signs to essentially mean, <u>If you can devote 20 percent of your assets to someone else's problem, you are overmanned! Those assets can be used more profitably elsewhere in a mission related role.</u> The laboratories did not, therefore, look upon Lehmann's memorandum as authority to act, but instead as another document alluding to policy, yet lacking guidance essential to effective implementation.

Even though the threat of personnel cuts due to manpower ceilings and/or declining budgets is a major limitation, it is not insurmountable. Remember, this is only a <u>perceived</u> constraint. When the Federal Council for Science and Technology recommended, in its policy statement of 1 March 1972, that OMB establish a special personnel ceiling reserve which could be made available to requesting agencies on a quick response basis, (68:2) OMB endorsed the Council's policy with one exception. OMB believes that no such reserve is necessary since "the existing personnel ceiling system is sufficiently flexible to take care of most of the Council's concerns." (41:26;74;85) In addition, on several occasions in the recent past, the manpower ceiling restrictions have been removed entirely. A test of the elimination of DOD's administrative ceilings on civilian employment for the trial period of fiscal year 1972 was terminated on 6 January 1972, as a result of budget decisions. (41:27) However, in memoranda of 7 August 1972, to the Assistant Secretaries of the services, Robert C. Moot, Assistant Secretary of Defense (Comptroller), rescinded the 6 January 1972 directive, thereby eliminating OSD civilian manpower ceilings. (88) This certainly is not a license to steal since funding limitations impose practical limits on hiring. Although the Director of Science and Technology, AFSC, issued a letter on EDECT (Elimination of Direct Hire Ceilings) in October, 1972, the laboratories/centers never perceived the guidance as relief from the manpower ceilings.

The long-term solution to the problem lies not in stop-gap measures, but in a permanent removal of manpower ceilings. This can best be accomplished by the adoption of a comprehensive financial management system (such as Project REFLEX) for all the DOD laboratories. The impact of this system is more fully discussed in Chapter VI. An alternative approach lies in the acceptance of a plan similar to the FCST policy proposal. Separate manpower accounting procedures should be used so that reimbursables do not count in any way against a laboratory's assigned strength. Conversations with AFSC/DOM, Director of Manpower and Organization, revealed that the machinery to do this exists but is not being fully utilized. Possible solutions and alternatives to the manpower problem are discussed more fully in Chapter VII.

CHAPTER VI

TRANSFER OF AIR FORCE R&D TO SYSTEMS DEVELOPMENT

While performing research for this study, the authors became convinced that any proposed methods and procedures to encourage increased Air Force participation in technology transfer to outside agencies for non-defense needs would be acceptable only if they can be readily integrated into the current Air Force R&D system. Therefore, an understanding of the R&D system, to include its organization and functions, is essential. Also, knowledge of the processes and procedures used to carry out these functions is a prerequisite to any meaningful analysis. The coupling requirements and methods of information exchange (transfer of technical information) within the Air Force and between industry and the Air Force must also be considered.

This chapter will not attempt to cover the material in detail. Supplemental information peculiar to AFSC is presented in Appendix D for the benefit of the reader who desires more information. Finally, the chapter evaluates current methods of handling interagency agreements and considers candidates for an Air Force technology transfer OPR.

Organization and Functions

The research and development mission of the Air Force is the responsibility of the Air Force Systems Command. The Command's R&D activities support three basic objectives: (1) to advance aerospace technology, (2) to apply new aerospace technology to operational systems, and (3) to acquire qualitatively superior aerospace systems. Organizationally, the command is composed of four product divisions, sixteen laboratories/centers, and two missile test ranges. As reflected by the organization chart (Figure 2, Appendix D), the laboratories are primarily concerned with the research and technology base (exploratory and advanced development). The product divisions are concerned with the development of systems and sub-systems, and the test centers possess special test facilities to support the testing and evaluation of system and hardware developments. The working divisions, laboratories, and centers receive direction and resource support from Headquarters AFSC and the Air Staff, DCS/R&D.

<u>Processes and Procedures</u>

This section will briefly describe the ways in which proposed weapon systems and requirements are translated into research and technology needs to guide the R&D programs of the laboratories/centers and the integration of research and technology needs into a coordinated planning, programming, and budgeting system (PPBS). These factors contribute significantly to the long-range planning necessary to develop R&D technology for future systems.

<u>Determination of Needs</u>. The corporate responsibilities of the Air Force are divided into 14 broad mission areas such as strategic offense, strategic defense, air lift, etc. The Joint Chiefs of Staff (JCS) and the Air Staff, upon analyzing the threat and considering national policy and priorities, produce a list of desired capabilities for each area. If attained, these capabilities will enhance the Air Force's ability to accomplish its mission. Inputs come from several sources: the <u>Joint Research and Development Objectives Document</u> (JRDOD), the <u>USAF Planning Concepts</u>, and <u>AFSC Planning Activity Reports</u> (PARs), operational command-generated <u>Required Operational Capability</u> (ROCs) documents, and the product divisions' compiled lists of technology needs.

Alternative ways to achieve the desired capabilities are then postulated in the form of Systems Concept Possibilities (SCPs). The Development Plans offices of the Product Divisions produce the majority of the SCPs. The desired capability in combination with the SCPs becomes a specific corporate objective which, in turn, generates Air Force technology needs. (142) These technology needs are prioritized and distributed to the technology (exploratory and advanced development) laboratories as technology planning guides (TPGs). The technology laboratories then align their specific technology planning objectives (TPOs) to match the needs (TPGs). The TPOs of the technology laboratories are oriented towards products, hardware, and sub-systems. To illustrate, Table 1 lists the TPOs of the Air Force Aero Propulsion Laboratory. (142) Appendix D explains how the TPOs, in turn, determine the thrust of the specific scientific and engineering effort in the research laboratories.

Role of Planning, Programming, and Budgeting. Although the planning, programming, and budgeting procedures of the technology and research laboratories were examined in detail, only a simplified description of the system and some of the significant new developments

AIR FORCE AERO PROPULSION LABORATORY

TECHNOLOGY PLANNING OBJECTIVES

1. Near Earth Orbit Spacecraft Power
2. Synchronous Orbit Spacecraft Power
3. Subsonic/Transonic/Supersonic Aircraft Power
4. High Mach Aircraft Propulsion
5. Aircraft and Spacecraft Laser Power
6. Large Aircraft Subsonic Cruise Propulsion
7. Transonic/Supersonic Fighter Bomber Aircraft Propulsion
8. Aircraft and Spacecraft Fire Protection
9. Low Volume Missile Propulsion
10. Long Range Air Launched Missile Propulsion
11. Limited Life Aircraft Propulsion
12. Low Detectability Aircraft Propulsion
13. V/STOL Aircraft Propulsion
14. Reentry Missile ECM Power
15. High Mach Vehicle Power
16. Subsonic Missile Propulsion
17. Surface Launched Missile Propulsion
18. Hypersonic Aircraft Propulsion
19. Aerospace Propulsion Capabilities

TABLE 1

in methodology are presented here and in Appendix D. In the past, laboratory plans and programs received very little direction from the top. Programs were essentially self-determined and funds were allocated on the basis of historical precedent. However, several factors have combined to improve the orientation of laboratory plans and programs. These factors include: (1) the requirement to implement the DOD PPB System, (2) the decreasing R&D budget and manpower authorizations, and (3) the development of more top-level control devices.

The planning, programming, and budgeting system of the laboratories is now in concert with the Air Force and DOD system. Technology and research planning guides are issued annually. Laboratory plans are submitted in proper budget format; that is, they provide a breakout of required resources (manpower, funds, equipment, etc.) at sub-element, project, and work unit levels. The plans go through a series of reviews and revisions at laboratory and headquarters level before the laboratory programs are finalized and before financial resources are allocated at the start of the new fiscal year.

As a result of reductions in both fiscal and manpower resources and growing work loads, the pressure for better planning, programming, and budgeting has resulted in three significant trends: (1) the establishment of more relevant technology and research planning guides and objectives, (2) the review and assessment of plans to determine if the technology needs (objectives) and research objectives are being met by the proposed pl-- and (3) the distribution and subsequent monitoring of resource allocations and programs at command level.

The current revisions on the laboratory planning methodology should alleviate many of the past criticisms of the AFSC R&D planning, programming, and budgeting process. A compilation of some of the deficiencies is as follows:

1. SCPs lacked credibility and proper prioritization.

2. No credible long-range corporate goals.

3. No mission analysis implementation.

4. AFSC planning methodology not enforced.

5. Funds allocated historically.

6. Laboratory programs generally preceded plans.

7. Each laboratory feels it is unique, leading to a "not invented here" (NIH) attitude.

8. Poor communication and interfacing throughout the organizational structure. (127,142)

The improved system at AFSC for prioritizing the R&D needs should yield better, more relevant technology and research planning objectives to guide the plans and programs of the laboratories. In other words, the most critical desired capabilities are translated into the most critical technology needs for the laboratories. The programs can be structured accordingly in terms of the men and money required to provide the desired technology at the desired time. Through a common planning effort, the laboratories can coordinate technology development (materials, structures, propulsion, avionics) to satisfy the timing criteria for specific system requirements. With the technology laboratories playing a major role in the definition of research objectives, research programs should yield a better return on the technology base relevant to Air Force needs.

Coupling and Communication

The introduction of improved planning methodology does not in itself guarantee a productive R&D effort. For the system to be productive, the results of the laboratories' efforts must be applied either by the primary or secondary users. The key to truly effective transfer from the laboratory to another AFSC organization or to industry is the effectiveness of the communications linkage. The terms coupling, interface, communication, and technology transfer all refer to the multidirectional process of transfer of technical information. The transfer may involve research and development results, hardware development, systems integration, etc., and may occur between any of the units in the organizational structure and/or between the Air Force and industry. Information may flow vertically and horizontally in either direction.

Coupling Within the Air Force

The communications problems which exist within the Air Force became strikingly apparent during discussions with laboratory S&E personnel and with personnel from the plans and programs offices in various laboratories, ASD, and Headquarters AFSC. The information gathered was analyzed to determine the nature and efficiency of the transfer process during the AFSC planning and programming cycle. The material indicates that the most significant problems encountered when attempting to transfer technical information to support current and future systems developments are:

1. A lack of common terminology exists between

systems planners and laboratory engineers.

2. Systems people and product division development planners lack the authority to demand support from the laboratories.

3. The laboratories are reluctant to tie their programs to a single system or "star" in case the program is curtailed.

4. Systems development planners do not go to program reviews and/or do not ask for or insist on support.

5. The formal system of communication needs (research needs/technology needs) is given "lip service" only and not taken seriously.

6. Certain laboratories express autonomous attitudes (NIH factor) resulting from historical prejudices.

7. There is no precedent for systems planners and laboratories to cooperate with each other.

8. No valid incentives or procedures have been implemented to actively encourage cooperation and communication. AFSC goals (SCPs, PARs) lack long-range direction primarily as a result of poorly defined corporate objectives.

9. Active System Program Offices (SPOs) feel

the real-time response requirement of their technological and development problems is beyond the scope of the in-house laboratory capabilities.

The laboratory-SPO interaction is a two-way process. The transfer of in-house technological developments to systems or hardware projects is inefficient and, in some instances, non-existent. The impact of improper technology coupling between SPOs and in-house laboratories is illustrated by the failure of in-house advancements in low-light-level television to be utilized in subsequent systems development. The initiation of a project to produce a low-light-level television device to satisfy tactical requirements in Southeast Asia led to the development and procurement of a system inferior to one previously developed by an in-house laboratory. Attempts to correct the deficiencies in the commercial system finally resulted in the discovery of the previous in-house effort which satisfactorily met the operational requirements.

The inept coupling within the Air Force R&D structure is reflected by the indifferent passive attitude of the SPOs towards the in-house research and technology laboratories of the Air Force. According to many of the SPOs, interrogation of in-house Air Force or DOD capabilities is too burdensome and time consuming. Consequently, they request assistance directly from industrial contractors who are more aware of their particular needs.

Coupling With Industry

Ironically, the coupling interface between the Air Force and industry is more critical to the transfer of R&D results from the laboratory into systems developments than the direct interface between AFSC laboratories and the Systems Programs Offices which are responsible for the development. The blockages present in the Air Force communications network emphasize the significance of industry's contribution to the development of Air Force hardware and systems.

The methods and processes through which industry performs this function are examined in Appendix D. Fortunately, profit margins are powerful incentives that motivate industry to fill an important brokerage role (third-party transfer agent) between the laboratories, product divisions, and SPOs. Industrial firms contract for both the technological capability (technical needs) and the systems development. The Air Force is most fortunate that this external technology coupling-interface circuit functions effectively.

Air Force Technology Transfer OPR

The extent of Air Force involvement in direct support to outside agencies for both defense and non-defense needs is discussed in Chapter IV and illustrated by example in Appendix C. A summary of Air Force regulations pertinent to technology transfer to outside organizations is included in Appendix B. This section of the study closes the technology transfer loop, presents an evaluation of the methods of handling interagency agreements and technical documents, such as reports and abstracts, and considers candidates for the Air Force technology transfer OPR.

Plans Division (DLXP). The extent and nature of Air Force technology transfer activities can best be described as confusing, particularly with respect to formal documentation of the effort. The absence of a clearly designated office of primary responsibility at either Headquarters AFSC, or the Air Staff makes it extremely difficult to assess the effectiveness of the technology transfer and coupling effort of the Air Force.

An Applications Office was established on the staff of each AFSC laboratory in an attempt to improve the coupling interface between the laboratory and other Systems Command organizations. The Applications Office is responsible for the implementation of AFSC Regulation 80-29 (Appendix B) which provided for the documentation of Research and Technology Advances (RAs & TAs) and Research and Technology Needs (RNs & TNs). These documents were used primarily as coupling mechanisms to communicate needs and advances throughout the Air Force R&D community. This formal system proved to be largely ineffective, so the success of the Applications Office became contingent upon the degree of initiative and motivation of the one or two individuals assigned. Rarely were RNs and TNs incorporated into laboratory plans and programs.

The Operations Office of each laboratory also contributes to the coupling/interface efforts through the preparation of the monthly laboratory activity reports. The activity reports include a section on the most significant coupling activities both inside and outside the Air Force system. An individual within the Plans Division, Director of Science and Technology, Headquarters AFSC (DLXP), charged with the technology applications function, collects and files these reports. Because the Plans Division is not sufficiently manned to fully support a technology applications function in addition to its primary duties, the office serves mainly as a repository for the technology transfer information contained in the activity reports. (134) Before the elimination of TAs, TNs, RAs, and RNs the same individual was also charged with monitoring that effort.

Scientific and Technical Liaison Division (DLXL). A second candidate is the Scientific and Technical Liaison Division in the Office of the Director of Science and Technology. The primary functions of DLXL include: (1) monitor the scientific and technical information (STINFO) function within the AFSC laboratories; (2) disseminate Technical Objective Documents (TODs) to industry; and (3) monitor the efforts of technical liaison officers collocated at the three NASA facilities, the Naval Weapons Center, and the Canadian industrial areas. (117) The STINFO documents and TODs are passive transfer mechanisms designed to transmit technical information to potential industrial users--their purpose being to improve the contractual and independent R&D programs of industry for the benefit of the Air Force and DOD. The technical liaison officers maintain close surveillance on the aerospace and weapons developments of NASA and the Navy, thereby functioning as transfer agents to promote cooperation, reduce duplication, and transfer knowledge to the mutual benefit of all.

Logistics Plans Office AFSC/LGX. The third candidate for the technology transfer OPR is the Logistics Plans Office, DCS/Logistics, Headquarters AFSC. This office issued a letter in September, 1972, advising all AFSC laboratories that LGX had been designated the Command OPR for the support agreement program. (73) The letter further stated that LGX would maintain file copies of all agreements: interdepartmental/agency agreements between the Air Force and non-DOD Federal organization, interservice agreements between components of DOD to include the Advanced Research Projects Agency (ARPA), and memoranda of understanding between major commands within the Air Force. The letter also implied that all agreements, technical as well as logistic, were within the purview of this office. In practice, however, LGX personnel interpret their responsibilities and duties in accordance with Air Force Regulation 400-27 and AFSC Regulation 400-6, which limit the scope of support agreements to matters concerning logistical or administrative support, supplies, or equipment. Therefore, the office has discouraged the submission of all agreements involving technical support to other agencies. When queried for clarification of the support agreement program, LGX acknowledged that they were uncertain about who was the proper OPR for technical support agreements.

Directorate of Test (AFSC/DOV). The last candidate to be considered is the Office of the Directorate of Test, DCS/Operations, Headquarters AFSC. The charter for this organization is found in AFSC Regulation 27-5 (Appendix B) which establishes the Engineering Services Program (ESP). The program is designed to provide contract, development, engineering, or test support to non-AFSC organizations. The regulation provides for any type of reimbursable Research, Development, Test and Engineering (RDT&E) effort for agencies outside of AFSC, and in theory, covers the scope of active Air Force technology transfer programs. Again, theory and practice differ. The program has essentially been limited to satisfying requests from non-AFSC organizations for support on AFSC ranges or in its centers, e.g., Eastern or Western Test Range, Eglin range, Arnold Engineering Development Center, etc. However, many of the technology support projects for other agencies that were listed in the laboratory activity reports were monitored under the Engineering Services Program, notably the Aeromedical Research Laboratory (AMRL) agreements with the Department of Transportation (DOT).

<u>Comparison of Candidate OPRs</u>. A certain degree of overlap exists between each of the four offices in the control, collection, and monitoring of efforts to transfer technology to organizations outside AFSC. With the exception of the functioning of the liaison officers as active transfer agents between NASA and NWC, the Scientific and Technical Liaison Division is limited to the dissemination of technical documents and does not monitor the active interagency agreements of the laboratories. The technology applications role of the Plans Division has diminished to a simple function of storing information pertaining to technology applications outside of AFSC, including some of the reimbursable ESP interagency agreements.

The Logistics Plans Office and the Directorate of Test do not interpret their charters as including the formal documentation of an active technology transfer effort. The reluctance of these offices to handle interagency agreements involving active technology transfer projects with non-AFSC organizations is understandable. The Logistics Plans Office is under DCS/Logistics and is interested only in Host-Tenant Agreements involving logistic and administrative support, supplies, and equipment. The Directorate of Test, as part of DCS/Operations, is responsible for the operation of test centers and, not surprisingly, is concerned primarily with reimbursable agreements for the use of test facilities by non-AFSC agencies under the Engineering Services Program. Suggestions for resolving the problems resulting from the diffused responsibility of the OPRs for active and passive technology support to organizations outside AFSC, will be proposed in the next chapter.

CHAPTER VII

PROPOSED SOLUTIONS AND ALTERNATIVES FOR AN IMPROVED TECHNOLOGY TRANSFER PROGRAM

Introduction

The preceding chapters have set the stage for the consideration of proposed solutions and alternatives for expanding and improving the current Air Force technology transfer effort. Before discussing ways to overcome the barriers to expanded participation and suggesting alternative ways to implement the proposed solutions, a brief restatement of the broad objectives, specific goals, and the expected benefits of the proposed program is in order.

Broad Objective. As discussed in Chapter II, the Congress, the Executive branch, and the American people have shown increased concern about the application of DOD advanced technologies to solve many of the serious problems facing our society. Consequently, DOD and the Air Force have incurred a dual responsibility to maintain technological superiority in weapons systems development for the preservation of national security and to participate in the quest for technological solutions to domestic problems. In an austere environment where countless demands are being made against limited resources, the necessity to meet these combined responsibilities requires the integration and cooperation of all the technological resources of the nation. The implementation of an expanded Air Force technology program will contribute to the achievement of the overall objective.

Specific Goals. The specific goals of this twofold mission can be realized through an Air Force technology transfer program which adheres to the following guidelines:

1. Investigate R&D projects of joint interest with both defense and civil agencies with or without reimbursable funding.

2. Support reimbursable efforts for non-defense needs that require minimal manpower and adaptive engineering. Give priority to urgent social problems dealing with Federal non-defense agencies and State and local governments.

3. Encourage use of existing and unique Air Force RDT&E facilities, equipment, and scientific capabilities on a noninterference basis with outside organizations

(including other AF components).

4. Make every effort to transfer only unique technology and to include the participation of industry in all support efforts.

5. Transfer scientific and technological advances to the SBA technology utilization division. Encourage laboratory scientists and engineers to cooperate in a consultation role with small business.

6. Help establish specific competences in Federal, State, and local governments.

The theme underlying each of these specific goals is the optimum utilization of all Federal R&D resources. However, the implementation of the non-defense transfer function must be secondary to the primary mission of the AFSC components and should not impair any of the defense-related efforts. Priority, therefore, should be given to independent or joint transfer programs which involve mission-related work.

Expected Benefits. A well-coordinated technology transfer program that is integrated into a well managed AFSC R&D effort can render benefits to both outside agencies and the Air Force. A list of the possibilities follows:

1. Benefits to Outside Agencies.

a. Minimize duplication of efforts.

b. Help solve important domestic problems.

c. Stimulate economy of the civilian sector.

d. Improve cooperation and coordination with the Air Force.

2. Benefits to the Air Force.

a. Improve cooperation with other agencies.

b. Help maintain a broad technology base.

c. Improve the Air Force image in the public sector and in the Congress.

d. Help recruit young talent and reduce the age and grade imbalance within the organization.

e. Enhance defense mission programs.

Supporting rationale for the benefits outlined above was discussed in Chapter V. The following sections will discuss ways to overcome the <u>significant</u> real and perceived barriers: legal, fear of Congressional censure, manpower, policy, management, and organizational structure. Many of these obstacles and the methods of surmounting them are interrelated to varying degrees. These interdependences will be noted when deemed appropriate.

Overcoming the Barriers

Legal. Solutions to the problems created by the legal barriers were alluded to in Chapter V. Steps are being taken to provide patent licensing to private firms who desire to apply technology protected by government-owned patents.

Legal restrictions on the expenditure of public funds apparently do not apply to efforts performed by DOD laboratories for outside agencies when the work is funded by the outside agency. Machinery to provide funding exists or can be developed.

Congressional Censure. This is a perceived barrier in the truest sense of the word. There is no way to guarantee that any program will be immune from Congressional criticism of one form or another. The only defense is a sound, well managed program that can be defended even under the most careful scrutiny.

Manpower and Policy. The solutions to the problems associated with lack of policy guidance and manpower ceiling restrictions are closely interrelated. Despite policy guidance from the Office of the Assistant Secretary of the Air Force (R&D) and Headquarters AFSC which recommended interagency support, many technology transfer programs were not undertaken for fear of manpower reductions. As discussed earlier, policy without firm guidance gives way to ambiguity and excuses for non-participation at the lower levels. Couple the absence of true managerial endorsement with the fear of manpower reductions, and the working-level manager will perceive that transfer projects which use manpower for purposes not directly involved in the defense mission are extremely vulnerable. Reimbursable efforts, which include the re-payment of overhead and personnel costs, do not free the laboratories from manpower limitations. The authors' personal observations revealed that manpower ceilings and time-consuming manpower request procedures are in existence, if not flourishing, at the Air Staff and Head-quarters AFSC. Although civilian manpower ceilings were removed by the OSD Comptroller in August, 1972, and by AFSC/DL in October, 1972, nothing has changed with respect to the restrictive nature of the hiring limitations and controls on the laboratories. The serious ramifications of current manpower ceilings and procedures on the ef-ficiency of DOD laboratories are highlighted in the GAO study. (19:1) Examples to illustrate the impact on the technology base and the importance of Project REFLEX are contained in Appendix F.

Under the present restrictions, the environment for technicial support to agencies outside the Air Force does not appear favorable. What can be done? First, interagency programs of joint interest and with joint funding should be encouraged. In some cases, overall manpower requirements may be reduced by these cooperative ventures. Certainly, R&D productivity should increase. Secondly, small programs under $25,000 could be undertaken with little impact on available resources. Larger, reimbursable projects can be accomplished by involving a large number of S&E personnel, providing that each devotes only a fraction of his time to the transfer effort.

A third way to overcome this manpower restriction in those Air Force laboratories which do not enjoy the benefits of REFLEX can be found in the planning and programming process. When submitting laboratory plans at the start of each new planning cycle, the laboratories can forecast a specified level of reimbursable funds from non-DOD agencies. Since accurate forecasting, 12 to 15 months in advance, is difficult, the total reimbursable (forecasted) funds for all AFSC components could be converted to an aggregate number of average manyears at Headquarters AFSC/DOM. The reimbursable figures can then be used as flexible resources during the actual program year.

In times of manpower ceilings, this would permit allocation of additional manpower to laboratories supporting reimbursable programs and would possibly provide a hedge against manpower reductions during times of manpower cuts. The reimbursable figure should represent the difference between funds received and funds used in order to reflect the accurate level of reimbursable support to AFSC. Of course, the ideal situation would be the replacement of combined fiscal and manpower constraints with financial management.

Management and Organization. Chapters V and VI discussed some of the problems which can best be addressed through improved management and organization. The optimum use of our limited resources to satisfy defense and non-defense needs urgently requires the vital and motivated output of all managers and employees in the Air Force R&D family.

The impact of management on human behavior and productivity is the critical factor in achieving the demanding goals of insuring national security and curing domestic ills. Realizing the barriers to innovative thinking and communication that a bureaucratic structure like the Air Force inherently presents only makes the tasks of all supervisors more difficult. However, no one can afford to ignore the tremendous challenge that the future presents. The current situation is already approaching emergency proportions; this fact is evidenced by the growing number of management controls being introduced at the top levels (Congress, OMB, DOD, et al.).

The ultimate thrust of these controls is to insure that the country's tremendous investment in defense is being optimized. Consequently, close analysis of programs in terms of cost, timeliness, and payoff is being exercised to attain the goal of providing greater advocacy for DOD efforts. Many potential benefits should result: determination of better, more significant goals; reduction in duplication of efforts; and orientation of programs to fill the most critical needs. Naturally, this centralization of control will be effected through budget controls, which should serve as a strong motivator.

Potential candidates for a technology transfer OPR were discussed and evaluated in Chapter VI. The fragmentation of the existing transfer effort appears to be a function of the organizational structure itself. A large network composed of small, fragmented groups with divided responsibilities seems to be the very nature of a bureaucratic organization. Since the entire range of managerial responsibilities (manpower, funding, services, procurement, etc.) impacts on the smallest group (which is the work unit), and since each function has its own separate organizational chain, it is not surprising that parallel, yet independent, controls and constraints develop. It is no small wonder that the manager at the working level is frustrated in his attempts to adjust the resources available to him to accomplish the job.

This fragmentation also prevents the optimum use of technical resources, including documents, equipment, test facilities, supplies, and knowledge. A lack of awareness of existing technical resources creates a situation in which many problems are either solved by duplicative scientific efforts at extra cost or are not solved at all. In an austere climate of budget restrictions, the Air Force cannot afford the luxury of duplication (or omission) of effort caused by a multicompartmentalized organizational structure.

An active technology transfer program becomes more important in such an environment whether it directly supports the defense mission or not. The ability of the third-party transfer agent to cut across organization boundaries is extremely useful. The transfer agent's value in a bureaucratic structure cannot be over-emphasized. For example, Mr. Harold Metcalf, the broker for the non-defense programs of the DOD consortium, and the Air Force Materials Laboratory (AFML) engineers who are collocated in key SPOs in the Aeronautical Systems Division (ASD) have both been highly successful in transferring technology. The proposed solutions and alternatives offered in the next section are oriented toward the increased use of technology transfer agents and the removal of the organizational structure blockages.

Proposed Solutions

Philosophy. An active technology transfer structure should be as flexible and non-constraining as possible through a process of centralized policy and decentralized execution. Decentralized execution is crucial for the success of the program. One of the fears expressed by individuals presently involved in transfer activities is that a formal system would erode the freedom with which the donor and the user can operate. The concern that a broad, formal program would eventually "begin to involve the bureaucratic hierachy of the DOD which could be the 'kiss of death' for this imaginative program both in terms of coordinating the technical efforts and interactions" has been recognized by the office of DDR&E. (99:Figure 9)

The technology transfer function must be staffed at the laboratory, Major Command (AFSC, etc.), and the Air Staff levels. This tiered staffing is necessary not from a need for command and control but to provide a proper level of contact for potential users of Air Force technology. For example, a State government desiring assistance in the area of materials technology could make initial inquiries at the structure level which is most convenient and obvious to the State agents. Eventually, personal contact regarding specific technology should occur at the laboratory level, either through reference from the higher levels or direct contact by the user.

The following proposals for expanding the transfer of Air Force technology vary in scope and potential: the more ambitious the proposal, the greater the potential and the greater the initial investment in terms of manpower and money. The proposals of wider breadth include an analysis function of the available technical information that is handled at AFSC, with the ultimate goal of better coordination and utilization of all AFSC R&D projects and facilities.

Solutions and Alternatives. The authors realize that the details of some of the suggestions may be inapplicable due to insufficient knowledge of the transfer media and the purposes and functions of various offices at AFSC. However, they do feel that certain aspects of the proposed alternatives can be implemented at a minimal investment and yield substantial improvements. At the very least, these suggestions should serve as baseline models for more extensive study and analysis.

I. Participation in DOD Consortium. The DOD Consortium of laboratories has proven to be an effective way to pursue a technology transfer program utilizing the resources of DOD laboratories. The Air Force laboratories should join the Consortium, thereby capitalizing on the experience of the current members and adding to the pool of technical resources available to solve the non-defense problems of society. The logical point of contact between the Consortium and each Air Force laboratory is the laboratory Applications Office. The responsibilities of the office should be expanded to include:

1. The functions of an active transfer agent with all other R&D organizations. Coupling for defense work should concentrate on Air Force laboratories, product divisions, SPOs, the other DOD components, and the Defense agencies. Interfacing for non-defense technology exchange should occur between the Consortium broker, the

SBA technology utilization division and the technology transfer contacts of other Federal civil agencies, State, and local governments.

2. The maintenance of records containing all interorganizational agreements involving the laboratory and incorporation of the STINFO function.

3. The compilation and transmittal of laboratory technical advances, documents, and unique facilities/capabilities that may offer technology potential to outside agencies. Develop techniques such as AFAL TRACE abstracts for dissemination to outside users. (Refer to page 12.)

4. The interaction with the laboratory Plans Office and laboratory engineers when programs, facilities, and capabilities outside the laboratory may possibly be of benefit to laboratory efforts.

5. The dissemination of information pertaining to significant Air Force R&D technology applications in the fields of health, energy, transportation, etc., to the public via the local Information Office.

6. Significant laboratory technology applications and spin-offs for the public and private sectors should be transmitted to a focal point at AFSC such as AFSC/STLD to provide higher level management visibility. (See discussion in next two major suggestions).

II. Designation of Technology Transfer OPRs. Chapter VI indicated that the responsibilities for technology transfer-related efforts are dispersed throughout the Headquarters AFSC staff. As a result of this fragmentation, opportunities are frequently missed and Command embarrassment can sometimes occur. General Brown's letter was actually promulgated in an attempt to prevent embarrassment of this type. (67) The following realignment of OPRs is proposed:

1. The Scientific and Technical Liaison Division (STLD) (AFSC/DLXL) should be designated as the OPR for all technical agreements (cooperative or independent) involving laboratory support to outside organizations. AFSC Regulation 27-5, covering the Engineering Services Program, should be revised to reflect this change. The STLD office should interface with the Applications Office at the laboratory level to maintain currency on all interagency agreements. The responsibilities of the Applications Office presently performed by the Plans Division (AFSC/DLXP) should be transferred to the STLD office.

2. The Directorate of Test/DCS Operations (AFSC/DOV) should be responsible for all documentation involving Test Center support to outside agencies.

3. The Logistics Plans Office/DCS Logistics

(AFSC/LGX) should be responsible for all Host-Tenant agreements.

In fulfilling its expanded responsibilities, the Scientific and Technical Liaison Division should assume the role of an active third-party transfer agent. Responsibilities in this capacity include:

1. The coupling with the DOD Consortium broker and DDR&E (R&AT) as contacts for possible Air Force technology transfer with civil agencies.

2. The interaction with the technology utilization division at SBA on possibilities of providing Air Force technology to small businesses, coordinating the activities with the Small Business Office (PPB) at AFSC.

3. The dissemination of information (pertaining to use of Air Force technologies) to associations of State and local governments.

4. The interfacing with the Applications Offices at the laboratories on all items of technology transfer which concern them (active and passive). More importantly, the tracking of all significant laboratory applications and spin-offs to the civil sector for distribution to potential users (industry, SBA, etc.) and Air Staff-DOD management, Congress, and the American public.

III. Enlarged Integrated Technology Transfer Program. To accomplish the goals and objectives (pages

106, 107), the Air Force participation in programs to transfer technology to non-defense applications should be expanded. This expansion can begin by enlarging the Scientific and Technical Liaison Division to include an analysis function to locate weaknesses in the technology base, including gaps, underfunded areas, and duplications of effort. The analysis function should be designed to accomplish the following:

1. The collection and separation of TODs, DD 1498s, Independent Research and Development 1498 type Forms, Form 1634s[2], and TNs into the seven broad technology areas used by the AFSC Research Planning Groups (RPGs). A further division into the technology base areas designated by the TCPs of DDR&E could also be accomplished.

2. The dissemination of these abstracts to the proper scientific level for analysis, possibly to the RPGs by coupling through the Plans Division at AFSC/DLXP.

3. The coordination and interfacing with both DLXP and AFSC/XR to improve definition of SCPs and technology research needs.

2. Form 1634 is a planning and programming summary form (one page) used by all DOD components to describe current and planned R&D efforts.

Several advantages will be gained by performing this analysis function:

1. Aid in preparation of TCPs.

2. Aid in preparation of better technology and research planning guides.

3. Help identify areas for potential cooperative programs in related defense work.

4. Improve communication between DLXP and XRP at AFSC and industry.

The second step of the expansion would be the creation of an "Industrial and Technical Liaison Office" at Air Staff level in Headquarters USAF. Responsibilities of this office would include:

1. The functions of a transfer agent and contact point for DCS/R&D on large technology transfer efforts, particularly with other civil agencies such as EPA, Federal Aviation Administration (FAA), etc.

2. The coordination of large interagency and interdepartmental (DOD) projects with the AFSC laboratories; the overall cognizance of AFSC interagency technology transfer program to enhance management visibility at the Air Staff level, and justify the integrated Air Force R&D program to DOD and to Congress.

3. The coordination of Air Force technical activities with the private and public sectors in

reference to large cooperative effrots between industry and associations of State and local governments.

4. The instigation of news releases on technology programs benefitting the domestic needs of the American public. Copies of these important domestic applications should be sent to the Congressional Liaison Committee at Air Staff and other appropriate offices in DOD and the Executive Branch.

Finally, the Federal Contract Research Centers, such as Aerospace Corporation, should be incorporated into the effort. These Centers possess a vast reservoir of expertise and can provide valuable assistance and adaptive engineering in transferring Air Force technology in order to solve the problems of society.

CHAPTER VIII

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. The extent of current Air Force support programs and technology transfer to civil agencies which can benefit the public sector is not being properly tracked and utilized by the Air Force R&D establishment. (pg 54)

2. Active technology transfer is occurring at the laboratory/center level on a random, ad hoc basis rather than a systematic one. The support and encouragement of Air Staff and AFSC management is essential to stimulate greater participation in technology transfer. (pg 73).

3. Air Force R&D support to outside agencies should be oriented towards cooperative, mission-related efforts and to those non-defense projects which require the unique capabilities or facilities of the laboratories.

4. The use of technical liaison (transfer agent) functions as a vehicle to deliver Air Force technology to outside agencies is more critical than ever in the present environment of tight budgets and increased workloads. (pg 114)

5. The present technology transfer effort should be low-key and flexible, relying principally on third-party transfer agents at the laboratory level. The responsibilities for technical exchange (active and passive) to organizations outside the laboratory should be monitored and coordinated through one focal point in the laboratory.

6. The condensation of technical results of Air Force R&D programs into more application oriented and user comprehendable forms is essential to a more efficient technology transfer effort, especially with civil agencies such as SBA. (pg 54) Procedures and techniques of disseminating Air Force technological capabilities and ascertaining technological needs of potential users must also be improved.

7. The consolidation of all interagency technical functions (including non-defense applications) that involve the AFSC laboratories in one office at AFSC/DL is necessary for better management visibility and awareness. (OPR section, Ch. VI).

8. The implementation of an expanded technology transfer program for solutions to both defense and non-defense needs will result in the fuller utilization of Air Force R&D technical and physical resources, and is in the best interests of the Air Force. (Ch. V, Advantages).

Recommendations

The first recommendation is proferred as number one priority for immediate implementation. It will generate maximum benefits at a minimal cost in terms of manpower and money. Several of the other recommendations will also require only slight changes in physical and financial resources, while offering some major advantages. The authors recommend that:

1. AFSC establish AFSC/DLXL (Scientific and Technical Liaison Division) as the focal point or OPR to track and publicize all significant R&D programs, technology spin-offs, and technology transfer activities applicable to non-defense needs. The use of devices and/or mechanisms to transmit these developments to the private sector, civil agencies, Congress, etc. is of utmost importance as a vehicle for providing much needed visibility for the contribution of AF technology to the well-being of the American public. (Suggestion II, pg 120).

2. AFSC/DLXL be responsible for all technology transfer activities involving the laboratories. The functions of this office should include collection and dissemination of all laboratory technical documents, the consolidation of all interagency agreements involving the laboratories, and the coordination between the potential users

of the Air Force technology and the laboratories (pgs 119, 120)

3. AFSC/DL encourage the individual laboratories to participate in the DOD technology transfer consortium by providing more specific directives and guidelines such as given on page 106.

4. The laboratories designate an individual in the Applications Office as the focal point for all passive and active technology transfer activities (including STINFO) for the laboratory. His responsibilities should include all those outlined in Suggestion I as discussed in Chapter VII. (pg 117, 118).

5. The laboratory directors encourage Scientific and Engineering personnel to consider secondary applications of their R&D efforts and cooperate with potential users. Potential applications of completed programs to non-defense needs should be included in the information reported on the DD 1498 forms and in the laboratory technical reports.

6. The DCS/R&D and AFSC management study current methods and procedures of communicating technology capabilities and needs to the private and civil sectors. Possibly, better integration and use of devices such as the TOD, PAR, ROC, NIP, etc., could markedly increase the cost effectiveness of developing technology for new weapon systems and sub-systems via improved teamwork among all

the technological resources of the United States.

In closing, the authors urge Air Force senior management to view an expanded technology transfer program as a valuable opportunity toward optimization of Air Force RDT&E resources for future defense requirements. The demands of the American public for solutions to unsolved societal problems will continue to place greater pressure on advanced technology for the answers. Therefore, DOD and Air Force budgets may well be influenced by the increased demands of Federal civil agencies and Congress to satisfy domestic needs. The authors feel that it is in the best interests of the Air Force to seize this opportunity to maximizing the transfer process by minimizing transfer barriers (administrative, organizational, communicative, etc.). The full utilization of DOD's advanced scientific and technical resources can play a major role in providing for the social well-being of the nation as well as its national security.

The breadth, complexity, and ramifications of an expanded, integrated Air Force technology transfer program as discussed in Chapter VII, Suggestion III, requires that this subject receive a further in depth analysis. The authors are firmly convinced that a properly managed, expanded Air Force Technology Transfer program can produce far reaching positive consequences and benefits to the overall RDT&E effort of the Air Force. Therefore, the authors strongly recommend that this subject be studied in more depth at AFSC Headquarters and/or Air Staff levels.

APPENDIX A

POLICY

Chapter III of this study discusses the official policy which forms the framework for technology transfer as it exists today. Necessarily, much of the relevant material was omitted from the body of the chapter for the sake of clarity and brevity. This appendix contains some of that material.

Executive Policy

The key elements of President Nixon's strategy for effective allocation of Federal scientific and technological resources are:

1. Maintenance of strong R&D programs in space and defense.

2. Application of the nation's scientific and technology base to domestic problems.

3. Stimulation of R&D efforts in both the public and private sectors, with emphasis on those areas where technology is lacking.

4. Employment of technology-oriented Federal

agencies in support of agencies with social missions.

5. Focus of resources on specific achievements where breakthroughs are most likely. (52:3,4)

The President also stressed the need for partnership between Federal and State and local governments in which the Federal government should capitalize on its ability to mass R&D resources, while the State and local levels should concentrate on identifying the specific domestic problems to which the Federal resources can be applied.

To stimulate the collaboration and consultation necessary for a strong partnership, the President recommends the development of systematic mechanisms to communicate the priority needs of the State and local governments to the appropriate Federal agencies. These needs can then be integrated into the Federal R&D planning process. In addition, the mechanisms should be designed to assure State and local government access to the Federal technology resources. Thus, the technology transfer system envisioned will stress two-way communications between the high-technology Federal agencies and all potential users in Federal, State, and local government agencies. (52:8)

Federal Council for Science and Technology Policy

The Federal Council for Science and Technology further amplified the Executive policy for expanded interagency cooperation in the use of Federal laboratories. This policy recommends that:

> . . . existing research and development capabilities in Federal establishments be utilized effectively to define and solve technological problems and to guide the technical content of policy decisions relating to some of the urgent national civilian needs, e.g., environment, pollution, transportation, health, housing, communication, agriculture and forest resources, water and land resources, and energy. (68:1)

The policy recommends that existing Federal laboratory capabilities be used whenever possible instead of creating new or additional capabilities and encourages all agencies to develop appropriate coordinating mechanisms to ensure effective interagency collaboration. (68:1) These mechanisms should provide for the documentation of cooperative activities of a continuing nature by means of formal interagency agreements. Thus, in order to achieve the optimum utilization of existing resources, the FCST recommends that:

1. Each agency designate an office as focal point for that agency's technology transfer efforts.

2. The formal technology transfer mechanisms established should be consistent with existing agreements

and should insure that cooperation is encouraged, not inhibited. (68:3)

Congressional Policy

Technology Assessment Act. This Act was passed in order to establish a mechanism to investigate the potential ramifications of technological applications with respect to the formulation of public policy on existing or emerging national problems. (58:1) The Act creates the Office of Technology Assessment within, and responsible to, the legislative branch of the government. The basic function of the Office is to provide early indications of the potential beneficial or adverse impact of technological applications and to perform other assessment activities as directed by Congress. In addition, the Office maintains continuing coordination with the National Science Foundation to avoid duplication of effort in technology assessment programs. The Office was also authorized to secure technical assistance as needed from other departments or agencies. The major impact of this act on DOD R&D programs will probably be felt through the imposition of additional requirements for the detailed technical justification of proposed programs. Congressional scrutiny will most certainly intensify as a result of this increased capability.

Both the Technology Assessment Act and S-32 are attempts by Congress to gain a more significant role in the formation of national science policy.

Federal Technology Transfer Act. This bill proposes the establishment of an office for Federal Technology Transfer. This office would have a charter to establish and administer a program to facilitate technology transfer by:

1. Providing for R&D in all aspects of technology transfer.

2. Establishing regional centers to first identify the needs of potential users and then to effectively disseminate the necessary technology to meet their needs.

The bill would also empower the Director of the Office for Federal Technology Transfer to use, with consent, the services, equipment, personnel, and facilities of Federal and other agencies, with or without reimbursement.

An alternative proposal is being considered by Representative Barry M. Goldwater, Jr. His plan would create an Office for Technology Transfer with similar functions. However, the office will be located in the Department of Commerce rather than in the National

Science Foundation. In addition, the Goldwater plan would incorporate the functions of the present NASA Technology Utilization Program.

Navy Policy

The most important element in the Navy program is the transfer agent. He educates Navy personnel on the technological needs of the civil agencies and, in turn, demonstrates relevant Navy technology to the appropriate civil agencies. In addition, he establishes the communication link between the potential user and the technology developer once a match has been determined.

In addition to using a transfer agent, the Navy has established and implemented their Military-Civilian Technology Transfer Program, clearly defining the concepts, policies, and principles at all levels of command. The Department of the Navy has designated the Chief of Naval Operations (CNO) as responsible for implementation of the policy to promote technology transfer. (50:1,2) The CNO in turn designated the Deputy Chief of Naval Material (Development) as Director of Military-Civilian Technology and Cooperative Development. The policies, responsibilities, and principles of the program are outlined for subordinate commanders in NAVMAT Instruction 5700.2. (51:1,2)

The goals of the program are to:

1. Transfer research and technology to civil agencies to preclude duplication of technological development.

2. Adapt existing technology to solve non-defense problems, doing so with minimum cost to the government.

3. Investigate problems of joint interest to both defense and civilian agencies.

4. Make unique Navy resources available to civil agencies for the solution of their problems on a non-interference basis.

APPENDIX B

AUTHORITY FOR USAF TECHNOLOGY TRANSFER

Many Air Force and Air Force Systems Command regulations address various aspects of technology transfer. This appendix summarizes the impact of these regulations on technology transfer efforts, with emphasis on Air Force policy, passive transfer mechanisms, and active technology transfer programs.

Air Force Regulation 80-1, Air Force Research and Development

This regulation establishes the general Air Force policies for Research and Development (R&D). These policies direct the Air Force to develop and maintain a competent scientific, engineering, and management capability. This capability should provide a superior technological base and should allow the necessary flexibility to effectively exploit technological breakthroughs. As stated in Chapter V, the establishment of an active technology transfer program would allow the maintenance of a more comprehensive capability than would otherwise be possible.

The policies further direct the Air Force to conduct joint R&D with other military services and Federal agencies when these efforts are in the national interest. In addition, the Air Force should use the results of R&D conducted by other Services and Federal agencies when these results will satisfy an Air Force need. The implementation of these policies requires an effective technology transfer mechanism, both within the Department of Defense and within the Federal government. This mechanism must insure a timely and comprehensive communication of the technological needs and capabilities of each agency.

Air Force Regulation 80-2, Documents Used in the Management of Air Force Research and Development

This regulation prescribes the documentation necessary to fully define and describe Air Force technological efforts. Although these documents are primarily intended to be management tools in the programming and funding of R&D projects, they also provide the input for the Index of USAF R&D Projects, Priorities and Program Elements. This index is thus a comprehensive listing of Air Force technological efforts, together with the responsible Air Force elements. The regulation further directs the Air

Force to insure that proposed research and development projects do not duplicate work either within or outside the Air Force. The identification of unnecessary duplication of efforts requires some mechanism that provides a comprehensive transfer of information regarding ongoing technological efforts throughout the Federal government.

Air Force Regulation 80-3, Management of Air Force In-House Research and Development Laboratories

This regulation establishes those policies that specifically apply to Air Force in-house research and development laboratories. These laboratories are responsible for assuring that technological advancements are identified for rapid Air Force exploitation. As such, they provide the principle Air Force interface with the entire scientific and engineering community. In addition, the regulation directs the laboratories to provide prompt and wide dissemination of the results of their efforts to all interested agencies.

Air Force Regulation 80-4, Air Force Policy on the Support of Research

This regulation states the general policy on the conduct and support of Air Force scientific research.

This policy directs the Air Force to maintain a strong scientific base in order to exploit technological breakthroughs. An active technology transfer program would enhance this capability. The policy further directs the Air Force to maintain effective communication with scientists in the Department of Defense, other Federal agencies, and the general scientific community. This communication should assure a comprehensive Air Force awareness of scientific progress and, thus, the full use of national scientific resources for Air Force needs. In addition to avoiding unnecessary duplication of effort and providing better resource management, the communication should promote mutual assistance in similar fields of activity.

The policy further states that Air Force in-house laboratories will be made available for use by scientists, in or out of the Federal government, when their work contributes to Air Force or Department of Defense interests. The policy also strongly encourages wide dissemination of the scientific information generated by the Air Force; however, the mechanisms mentioned stress passive techniques or informal, personal contacts within the scientific community.

Air Force Regulation 80-12, Work Unit Information System

This system, established by the Director of Defense Research and Engineering, has a three-fold objective: (1) to facilitate the exchange of technical and management information within the Department of Defense through the use of computer techniques, (2) to identify on-going research and technology efforts in order to allow coordination of these programs within the Department of Defense and to thus eliminate undesired duplication of effort, and (3) to identify specific scientific and engineering contacts in the various technical areas. In addition, the system provides data for interagency data collection or coordinating groups--the Interagency Life Science Exchange (ILSE), the Federal Council on Science and Technology (FCST), the Interagency Committee on Atmospheric Sciences (ICAS), the Committee on Academic Science and Engineering (CASE), and the Science Information Exchange of the Smithsonian Institute.

Air Force Regulation 80-19, Support of Nongovernmental Test and Evaluation

This regulation authorizes the Air Force to provide support services and facilities to nongovernmental organizations in those cases where such services or facilities are not readily available elsewhere. This support is subject to the following constraints: (1) the effort must be in the public interest, (2) a Federal executive agency must sponsor the effort, (3) the requesting organization must reimburse all costs, and (4) the effort must not interfere with the mission of the Air Force test facility. All support will have both Air Force and Major Command approval.

Air Force Regulation 80-40, The Scientific and Technical Information Program

This regulation explains the purpose of the Department of Defense Scientific and Technical Information (STINFO) program, namely, the dissemination of technical information resulting from Department of Defense research. The purpose of the Air Force STINFO program is to assist management in decision-making, resource allocation, and the elimination of unwarranted duplication of research and development efforts. The regulation directs the Air Force organizations involved in scientific and technical activities to promote wide dissemination of this information and, in so doing, to foster coupling activities. Within the Air Force Systems Command, the STINFO offices, located in the headquarters sections of Systems Command, its subordinate divisions, centers, and laboratories, are to take the lead and assist in technology transfer efforts. This regulation defines technology transfer as coupling the research and technology product with potential users of scientific and technical information to the benefit of the Air Force and Department of Defense organizations.

Air Force Regulation 80-44, Defense Documentation Center for Scientific and Technical Information

This regulation establishes the Defense Documentation Center as the focal point of the Air Force passive technology transfer mechanism and defines the eligible users as any Federal agency, contractor, or grantee.

Air Force Regulation 80-50, Use of Department of Defense Research Facilities by Academic Investigators

This regulation establishes the policy that Department of Defense specialized research facilities will be made available for research by academic investigators (1) who are working on research which has scientific merit, which relates to Department of Defense research objectives, or which furthers national research objectives; and (2) who agree to make their results available to all interested Government agencies. The usage of the facilities is subject to the following constraints:

(1) the effort must not interfere with the mission of the facility, (2) the effort must require only minimal technical support by the host organization, and (3) the investigator's sponsoring agency or institution must reimburse any significant additional operating costs (over $200).

Air Force Systems Command Regulation 27-5, Engineering Services

This regulation establishes the Engineering Services Program (ESP), whereby the Air Force Systems Command (AFSC) provides contract, development, engineering, or test support to any non-AFSC agency. The potential requesting agencies specified in this regulation are other Air Force major commands, other Department of Defense components, other defense-related agencies (AEC, NASA, FAA), other government agencies, foreign or international agencies, universities, and industries. The management policy of this program is that the Systems Command Headquarters will monitor and approve any significant ESP (one which requires more than four man-year effort, costs more than $25,000, or needs additional resources). The subordinate commands can monitor and approve all other ESPs, but they must report any resulting resource utilization to Headquarters, Air Force Systems Command. All projects under the ESP will be reimbursable efforts and must have either a Military Interdepartmental Purchase Request (MIPR) or fund citation. The office of primary responsibility for this program is the Director of Test Centers (DOV), DCS/Operations, HQ AFSC. Although the regulation states that the program applies to a broad area of services, the ESP as presently used focuses primarily on facility usage and ancillary support, e.g., use of the Eastern or Western Test Ranges, or use of the facilities at Arnold Engineering Developmental Center. However, some transfer of Air Force technology to other agencies does occur through this program, primarily Aerospace Medical Division efforts.

<u>Air Force Systems Command Regulation 80-2, Air Force Technical Objective Document Program</u>

This regulation establishes the Air Force Technical Objective Document (TOD) Program. This program transmits Air Force technical needs to industrial, academic, and governmental organizations and solicits their assistance in the solution of these needs. Thus, this program is a mechanism for technology transfer into the Air Force.

Air Force Systems Command Regulation 80-14,

AFSC Management and Scientific Information System (MASIS)

This regulation establishes the Air Force Systems Command Management and Scientific Information System (MASIS). In essence, it defines the responsibilities, and the records required, for implementation of a centralized, automated data bank for integrating management and scientific information related to the Systems Command field activities. In addition, this system satisfies the requirements prescribed by AFR 80-12.

Air Force Systems Command Regulation 80-20,

AFSC Technical Report Program

This regulation establishes the AFSC Technical Report Program to insure that results from all research, development, test, and evaluation efforts are documented and entered into the STINFO program prescribed by AFR 80-40.

Air Force Systems Command Regulation 80-23,

Research and Technology Support to AFSC Organizations

This regulation defines the command policies and establishes the responsibilities for an active intracommand technology transfer program. The policy states that Systems Command laboratories should maintain a superior technological base and, in addition, should provide the maximum possible support to the more applications-oriented organizations. The regulation further designates the applications office within each laboratory as the focal point for this support to other organizations. The policy also states that these laboratories will <u>actively</u> promote their capabilities and services to both present and potential requesting agencies.

Air Force Systems Command Regulation 80-24, AFSC Technical Facilities Register

This regulation establishes the Air Force Systems Command Technical Facilities Register, which contains technical descriptions of research and development facilities within the command. This information, published periodically as "Air Force Technical Facility Capability Key" (AFSCP 80-3) allows a potential technical user to determine the technological capabilities of Air Force facilities.

Air Force Systems Command Regulation 80-29, Research and Technology Coupling

This regulation establishes procedures for the transfer of information within Air Force Systems Command. The Research Needs (RN) and Technology Needs (TN) are mechanisms to document scientific or technological gaps, while the Research Advances (RA) and Technology Advances (TA) document important advances in research and technological capabilities. The regulation directs the additional distribution of Technology Needs to outside agencies through the facilities of the Defense Documentation Center. The regulation also prescribes coupling meetings to promote understanding, coordination, improvement and periodic assessment of this coupling process.

Air Force Systems Command Regulation 170-5, Defense Advanced Research Projects Agency (ARPA) Programs

This regulation explains the procedures for Systems Command support of ARPA programs. These programs relate to functions of two or more military departments that require centralized management within the Department of Defense.

APPENDIX C

EXAMPLES OF TECHNOLOGY TRANSFER TO AGENCIES OUTSIDE THE AIR FORCE

Research in preparation for this study revealed numerous examples of technology transfer occuring between the Air Force and outside agencies. The following examples provide an indication of the type of transfer taking place:

1. Civilian Application of TALAR IV Microwave Landing System. The FAA has commissioned a commercial version of the USAF TALAR IV from the Singer Kerfoot Company for landing approach guidance in California. The system was developed by Air Force Flight Dynamics Laboratory (AFFDL) to provide a new capability for low-visibility operation at strategic locations in SEA.

2. Civilian Application of Short-Backfire Antenna. Nurad, Inc., of Baltimore, Maryland, is commercially marketing the Short-Backfire antenna. This design has been used in mobile satellite-to-ground terminals of the Air Force, the Army, the Navy, and in the

TAC satellite communications system. This antenna development is finding applications for space communications of NASA and NOAA and in commercial UHF television. The research, design, and patents on this new antenna are from the Microwave Physics Laboratory at AFCRL.

3. Hearing Protection Measurements for National Standards. Aeromedical Research Laboratory is representing the Air Force on working groups of the Acoustical Society of America and the Safety Standards Board on the subject of the preparation of national standards for hearing protection. AMRL is cooperating with several Federal agencies including DOD, DOI, DOT/FAA, NASA, and EPA by resolving some technical questions on the implementation of the new measurement procedure.

4. Toxicity of Combustion Products from Aircraft Cabin Materials. A joint research effort with FAA to determine types and quantities of toxic gases released by burning the materials in the interior of aircraft. The eventual objective is to develop realistic hazard ratings in order to improve the safety of both military and civilian aviation.

5. Interagency Coordination of Low-Cost Solar Cell Program. Close coordination between engineers from AFAPL and NASA has been maintained to insure that the

low-cost solar cell programs remain complementary and provide the quickest payoff with the limited funds available. Based on satellite power requirements estimated by SAMSO, improvements such as cell size standardization and more effective production and assembly methods could yield $200M for the 1975-1985 time period.

6. Development of Method for Analysis of Nitrogen Oxides. The Analytical Chemistry Group of AFRPL is conducting research to develop a standard reference method for the analysis of nitrogen oxides emitted from stationary industrial sources. This technology is required for the enforcement of the National Emission Standards by EPA. This expertise resulted from an analysis capability needed for the development of military specifications for rocket propellants which contain oxides of nitrogen, and the research is funded by EPA at $65,000 for a one year effort.

7. Infrared Multispectral Reconnaissance Sensor for Water Polution. This infrared sensor was developed by AFAL for detection of tactical-type targets and was loaned by RADC to the US Geological Survey Water Resources Division, Albany, New York. The Survey Division conducted a joint program with the New York Department of Environmental Conservation to assess the ability of the airborne infrared system to detect thermal discharges, oil slicks,

and waste discharges.

8. Inter-City Transportation by Air Cushion Aircraft. The New York City Transportation Administration requested the technical assistance of AFFDL in developing a proposal to DOT to assess the potential of air cushion aircraft for rapid inter-city travel in the Northeast. This request resulted from a AFFDL briefing on the CC-115/ACLS program to the NYC Transportation Administration.

APPENDIX D

THE ROLE OF PLANNING, PROGRAMMING, AND COUPLING TO TECHNOLOGY TRANSFER

Chapter VI deals with this subject in sufficient depth for those with a basic understanding of the DOD PPB System. Supplementary material is presented here to provide a more complete and detailed picture.

Determination of Needs for Air Force Research Laboratories

The technology planning objectives are separated into seven all-inclusive categories of technical responsibility, such as Aerospace Vehicles, Propulsion, and Power, which provide guidance to the research organizations (AFCRL, ARL, FJSRL, AFOSR, etc.).

The needs of these broad technical areas, written in problem-oriented language, provide a method for relating research to Air Force corporate and technology objectives. (100:iii) The broad research categories are subdivided into as many smaller units, called research objectives (ROs), as are required to adequately cover the field. (125) The ROs are used to identify the specific types of research needed to bridge technological gaps and are required to support future technology concepts and programs. The research needs and objectives are translated into research plans and programs, which are rearranged into the more classical scientific disciplines known as Defense Research Science (DRS) sub-elements. This project-oriented realignment is functionally consistent with the technical responsibilities of the individual laboratory divisions and branches with the Laboratory plans format. (62) Figure 1 illustrates the interface between mission areas, technology areas, and DRS research areas.

Planning, Programming, and Budgeting

The Planning, Programming, Budgeting System (PPBS) is a coordinated series of events used to update the five-year defense program (FYDP). The FYDP is a management tool originally designed by former Secretary of Defense McNamara and his systems analysis specialist, Charles Hitch, employing a comprehensive yearly review system for military plans and strategy. (4:1) It has been refined and modified over the years and is used as an effective vehicle for making resource allocations and decisions regarding programs.

The entire Department of Defense force structure,

AF MISSION AREAS (TPG)	TECHNICAL AREAS (RPG&RO)	DRS RESEARCH AREAS
Strategic Offense	Aerospace Vehicles	General Physics
Strategic Defense	Propulsion & Power	Nuclear Physics
Close Air Support	Weaponry	Chemistry
Interdiction	Electronics	Mathematics
Counter Air	Biological/Human Resources	Electronics
Special Operations	Materials	Materials
Command, Control & Communications	Environmental Support	Mechanics
Surveillance & Recon		Energy Conversion
Intelligence		Terrestrial Sciences
Airlift		Atmospheric Sciences
Rescue		Astronomy & Astrophysics
Training		Biological & Medical Sciences
Mission Support		Behavioral & Social Sciences
Technical Base		

MISSION, RESEARCH, AND TECHNICAL AREAS

FIGURE 1

plans, and programs are now intimately associated with this PPBS cycle. The PPB process is an eighteen month cycle that commences with the Defense Policy and Planning Guidance (DPPG) document, which is issued by OSD to the Military Services every spring. The DPPG paper is in response to the broad military strategy contained in the Joint Strategic Objectives Plan (JSOP-I) which is compiled by the Joint Chiefs of Staff (JCS). Based on inputs from Congress, the President, and the OSD staff, the DPPG recommends changes in force and programs strategy in light of national priorities and DOD fiscal constraints. The Air Force then issues a Planning-Programming Guidance Memorandum (PPGM) that actually begins the cycle for Air Force components. This document contains the revised policy and planning guidance and includes fiscal, force, and materiel support planning guidance. The PPGM is forwarded to the major command. The commands supply the inputs to the Air Staff for preparation of the Program Objective Memoranda (POMs), which provide an assessment of the ten major programs which are arranged to identify broad areas of both forces and support. The POMs are arrayed in program element format (FYDP), and include new fiscal guidance constraints. After several iterations of review by OSD and OMB, and reclama by the

Military Departments, the Air Force consolidates its portion of the FYDP (the USAF Force and Financial Plan) late in the calendar year.

The Research and Development portion of the Program/Budget structure is the management responsibility of DDR&E within OSD. The funds appropriated for this major program area are known as RDT&E monies. The AF portion of this major program falls primarily into the 6.1, 6.2, and 6.3 program element categories which, in turn, are used to operate the [illegible] facilities of AFSC. (28:43) Program elements are the subdivisions of the major budget programs and are groupings of forces, manpower, and costs associated with an organization or a group of similar organizations.

Laboratory plans and programs resource costs are identified in each program element. The program elements are further subdivided into sub-elements at the working levels. As shown in Figure 1, the Defense Research Sciences (6.1) program element contains 13 sub-elements.

The continuing resolution of the Laboratory Management at Headquarters AFSC (AFSC/DL) (Figures 2 & 3) to improve the laboratories plans and programs is reflected by the following modifications introduced into the new FY75 planning cycle for the laboratories: (104)

HQ AIR FORCE SYSTEMS COMMAND

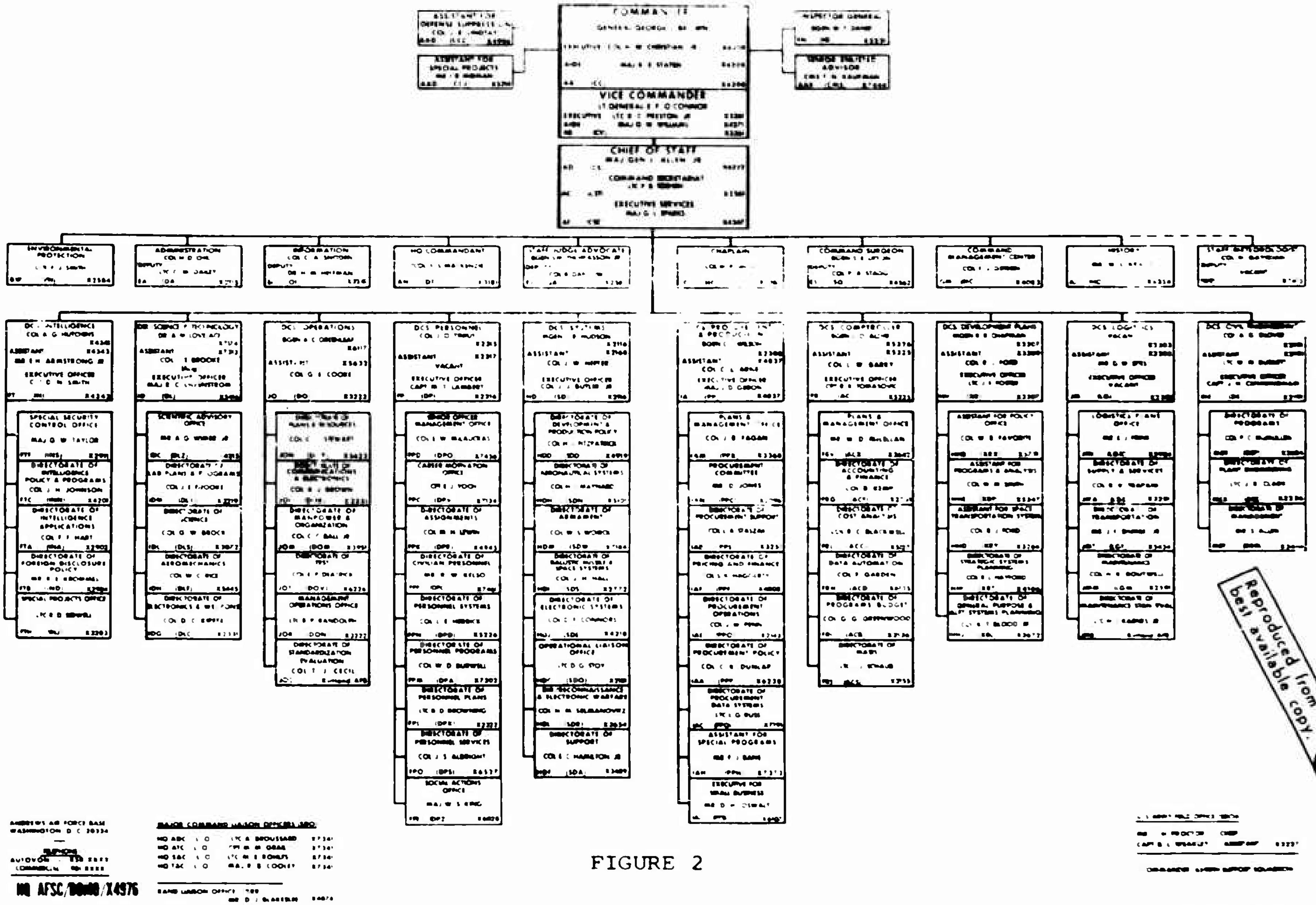

FIGURE 2

AFSC/DL ORGANIZATION

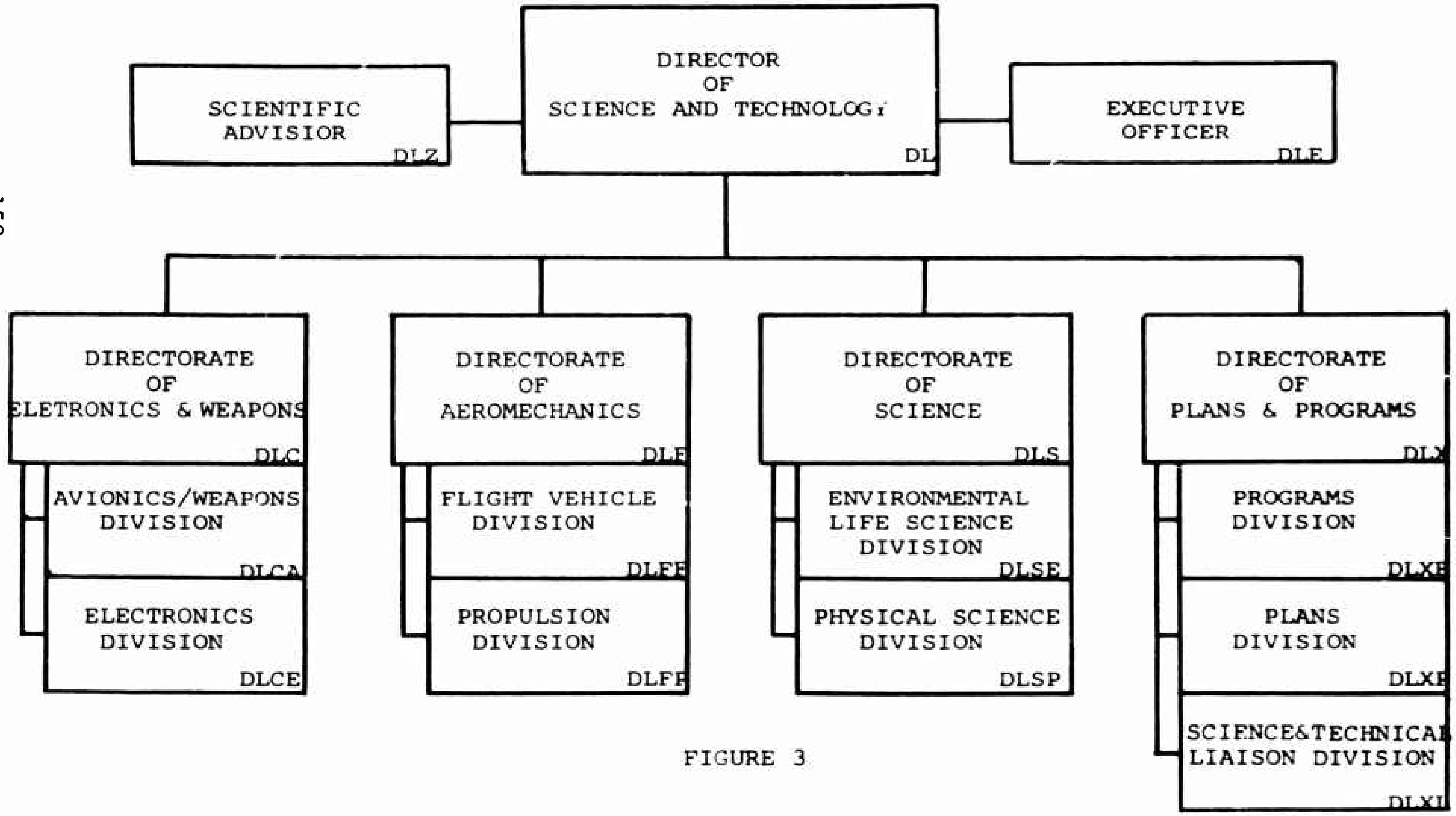

FIGURE 3

1. The research plans format for all laboratories will be identical.

2. Technology planning guidance will be prepared by mission area after review by the operational commands and the Development Plans offices at the product divisions. The System Concepts of TPGs (Part II) will be prioritized and revised by AFSC/XR(DCS/Development Plans) and distributed by AFSC/DLXP along with the planning guides. These modifications are intended to increase involvement with AFSC/XR and the AFSC Program Evaluation Group (PEG)[1] to assist in the plan to allocate resources by mission areas.

3. The manpower and financial resources of the laboratories (as shown in the Laboratory Plans) will be included in the AFSC Resource Plan.

4. The new planning methodology eliminates the requirement for Research Needs, Research Advances, and Technology Advances (Planned Revision AFSCR 80-29--See Appendix B).

5. The research objectives (of the research planning guide) will have greater inputs from the tech-

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[1]PEG--a group in HQ AFSC that evaluates resource requirements of individual program elements and formulates program recommendations for submission to the AFSC council.

nology laboratories. A chief scientist from a technology laboratory will lead planning and review groups that will determine the specific ROs and evaluate the resultant Laboratory Plans. (143)

6. Resource allocations from AFSC/DL (Directorate of Science and Technology) will be based on the advocacy of the Laboratory Plans to the peculiar R&D needs and objectives of the Air Force.

Coupling with Industry

A brief examination of the methods and processes of communication and information exchange with industry will complete this summary of how the defense mission requirements of the Air Force are accomplished. Industry determines the research and technology needs for systems and sub-system developments of the Air Force by interfacing three primary documents: the laboratory Technical Objectives Documents (TODs), and AFSC Planning Activities Reports (PARs), and the product divisions Technology Needs (TNs). (109) The TODs are summaries of the Laboratory Plans (i.e., the proposed R&D programs) with the sensitive information pertaining to funding and desired systems concepts removed. (117) These documents, coupled with the TNs of the product divisions, transmit the Air

Force research and technical needs to industry. Hopefully, this mechanism provides guidance to the internal R&D programs of industry, and helps direct some of the Independent Research and Development (IR&D) funds of industry towards the R&D needs of the Air Force. Since information directly coupling research and technology needs to current and proposed systems and hardware developments is removed from the TODs, industry correlates the exploratory and advanced development programs to systems and sub-systems concepts via the AFSC Planning Activity Reports (PARs). The PARs are summaries of Air Force systems and sub-systems developments (current and planned) which are available to industry. These documents are accessible only in person under controlled conditions at Headquarters AFSC. Therefore, industry is able to connect the R&D needs with the systems and develop the technological capability required for design, engineering, and production of new hardware through IR&D efforts, internally funded R&D, or exploratory and advanced development contracts with the AFSC laboratories.

New Initiatives Program

The recently developed New Initiatives Program is another method of communicating Air Force needs to the private sector and soliciting their response. The primary objective of the program is to stimulate innovative methods and ideas which will enhance the ability of the Air Force to accomplish its mission. The efforts are oriented towards novel approaches for potential applications which range from components to subsystems. In contrast to normal contract supported efforts, the New Initiatives efforts are constrained by neither time nor risk. Programs are selected on the basis of high payoff potential and are not intended to replace the routine "requests for proposals" and "unsolicited proposals." Programs are initiated through the New Initiatives Office (DCS/R&D) but are coordinated, evaluated, and funded by AFSC.

APPENDIX E

TECHNOLOGY TRANSFER FOR ELECTRICAL POWER GENERATION

Scientists in the Metallurgy and Ceramics Research Laboratory, Aerospace Research Laboratories (ARL/LL), have been conducting research over the past decade on the transport properties and associated defect structures of ceramic materials. Some of these research efforts have led to the development of ceramic compositions for special high temperature electrical applications. (27) One critical use for such materials is for ceramic electrodes and insulators in the channels of MHD electrical power generators. AFAPL is sponsoring the R&D of MHD power generation for potential Air Force applications, such as flight-weight power generators for weapons systems and stand-by power sources.

Realizing the MHD generators are critically dependent on the performance of the channel materials, ARL/LL scientists contacted the MHD project engineer at AFAPL and offered their specialized capability in electronic materials. Since a small business contractor, Systems Research Laboratories (SRL) of Dayton, Ohio, was conducting the research program on the AFAPL in-house MHD power system, a cooperative effort developed between SRL, AFAPL, and ARL. In response to in-house research results from ARL, new electrode and insulator materials were incorporated into a new MHD channel at AFAPL. The performance of this new channel has been excellent in terms of near theoretical maximum power output, erosion, and thermal stress resistance of ceramic channel materials.

As an outgrowth of the initial interlaboratory-contractor cooperation, an integrated AFAPL/ARL follow-on research effort with SRL was initiated. AFAPL funded more advanced engineering and development while ARL funded an electrode materials test program using new state-of-the-art compositions that were developed in-house. The program is now in progress.

Since MHD power generation is being considered for a large civilian power requirement, a joint MHD program has been proposed between AFAPL, SRL, and the Office of Coal Research (OCR) in the Department of the Interior. OCR is interested in generating MHD power for the general public either as a central base power station or, more likely, as a "topping" power source in the typical steam turbine power plant. (29) The interdisciplinary approach, the upgraded MHD test facility, and the experience and competence of the AFAPL/SRL team offer the potential for significant benefits to both the domestic and military sectors.

Not to be forgotten, is the continuing development effort to overcome critical limitations to long term MHD power generation, i.e., the improvement of ceramic channel materials. Further, the evolution of the combustion-driven MHD generator program of the Air Force is an example of technology transfer at its ultimate: transition of basic research to applied engineering development through interlaboratory/small business contractor cooperation, the growth of specific competence in the materials and electrical power generation areas in a small business, and the transfer of this advanced MHD technology to a Federal civil agency for the possible solution to an urgent domestic need.

APPENDIX F

IMPORTANCE OF TECHNOLOGY BASE AND PROJECT REFLEX

Maintain Technology Base

The need for a strong technology base, particularly in the area of basic research, cannot be overemphasized. Unfortunately, decreasing budgets and the corresponding reductions in manpower have already weakened the Air Force technology base. For example, the recent manpower cuts at the Aerospace Research Laboratories (ARL) eliminated 24 percent of the laboratory personnel, including two entire laboratories (the General Physics Laboratory and the Thermomechanics Laboratory). Two significant programs, the High Pressure Plasma Research Program of Thermomechanics and the Nuclear Cross-Sections for Systems Survivability/Vulnerability Design and Assessment Program of General Physics, were also phased out.

The objective of the Thermomechanics Laboratory effort was to extend the meager amount of knowledge which exists on the subject of the physics of high pressure plasmas. A unique and complex high pressure plasma facility capable of producing pressures up to 1000 atmospheres was developed at ARL. The only other known research effort of this kind is being conducted in Russia. The research results were aimed at providing transport property data for the prediction of heat transfer to re-entry vehicles, and for the construction of suitable design facilities which are needed for testing and development of advanced re-entry vehicles of the future.

The nuclear cross-sections program of General Physics laboratory was intended to meet Air Force requirements for nuclear reaction information needed for systems survivability/vulnerability assessment and the design of hardened systems. (110) This information would enable SAMSO to accurately predict the radiation environment and the effects of this environment on missile systems.

The impact of the elimination of this highly specialized scientific base may never be truly assessed since the payoff of research efforts of this type are not realized immediately. The important question is, will some critical technology gap develop that could create serious consequences in the future (technological break-through by our adversaries). Hopefully, this gap in the scientific base will be covered by other research groups, but there is no guarantee that this will occur.

Project REFLEX

Project REFLEX is a management experiment designed to test the exclusive use of fiscal controls in the management of selected DOD laboratories. Impetus for the program was provided by GAO and Civil Service Commission studies on the management of DOD R&D personnel. The studies noted that workload, funds, and manpower ceilings originated from three separate sources. Thus, the dual constraints of manpower and money greatly inhibit the flexibility of laboratory management in responding to changing priorities and new technological demands. (39:2)

Deputy Secretary of Defense David Packard instituted Project REFLEX after expressing his views in a letter to George Shultz, Director, OMB. (39:41) He noted that financial and program constraints would be far more effective controls on employment levels and mission effectiveness and that current procedures caused management to spend too much time and energy on the relationship between the job and the ceiling imposed. The more restrictive the ceiling controls, the greater the impact on the management operation.

The three Air Force laboratories (AFFDL, AFAL, AFADTL), which have operated under REFLEX since July, 1970, have enthusiastically endorsed the new system. (101)

The removal of the manpower ceilings and the elimination of the normal laborious procedures for hiring new personnel have provided much needed additional flexibility and range in performing the laboratories' missions. Other advantages include cost savings resulting from the conversion of contracted personal services to in-house capability, lowering of the average age and average civil service grade level, ability to hire highly competent personnel when they are available, and enhanced development of laboratory middle managers.

A laboratory working group has recommended a two year continuation of the experiment in a report on the Air Force portion of the Project REFLEX program. (101) Hopefully, the multiple benefits to be derived from this project will eventually lead to the acceptance of financial management in all the laboratories of AFSC.

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