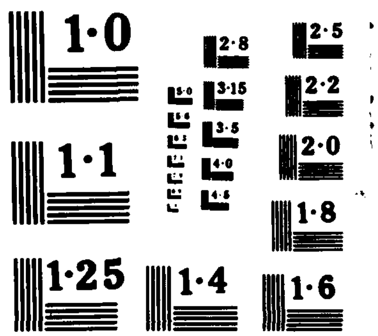
AD-A187 017 A STUDY OF FEDERAL TECHNOLOGY TRANSFER TO THE COMMERCIAL SECTOR(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF SYSTEMS AND LOGISTICS M J OLSEN SEP 87 AFIT/GLM/LSP/87S-52

1/2

UNCLASSIFIED F/G 5/2 NL


1·0
2·8
2·5
3·15
2·2
3·5
2·0
1·1
4·0
4·5
1·8
1·25
1·4
1·6

A STUDY OF FEDERAL TECHNOLOGY TRANSFER TO THE COMMERCIAL SECTOR

THESIS

Michael J. Olsen
Captain, USAF

AFIT/GLM/LSP/87S-52

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR FORCE INSTITUTE OF TECHNOLOGY

Wright-Patterson Air Force Base, Ohio

AFIT/GLM/LSP/87S-52

A STUDY OF FEDERAL TECHNOLOGY TRANSFER TO THE COMMERCIAL SECTOR

THESIS

Michael J. Olsen
Captain, USAF

AFIT/GLM/LSP/87S-52

Approved for public release; distribution unlimited

The contents of the document are technically accurate, and no sensitive items, detrimental ideas, or deleterious information is contained therein. Furthermore, the views expressed in the document are those of the author and do not necessarily reflect the views of the School of Systems and Logistics, the Air University, the United States Air Force, or the Department of Defense.

AFIT/GLM/LSP/87S-52

A STUDY OF FEDERAL TECHNOLOGY TRANSFER

TO THE COMMERCIAL SECTOR

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Logistics Management

Michael J. Olsen, BBA
Captain, USAF

September 1987

Acknowledgements

I am indebted to my thesis advisor, Major Charles M. Farr for his professional assistance, patience, and optimism throughout this effort. I also appreciate the sage advice and supportive critiques provided by my reader, Dr. Gill. Special thanks to Dr. Robert Premus, Wright State University, for his technical knowledge and assistance. Finally, thanks to Eve, my wife and friend, for her love and support.

Michael J. Olsen

Table of Contents

Page

List of Figures

AFIT/GLM/LSP/87S-52

Abstract

The Federal Technology Transfer Act of 1986 imposed legislative requirements on federal labs to take certain actions to facilitate the transfer of federally developed technology to the commercial sector. This study examined the requirements of the 1986 Act and had the following three specific objectives: 1) to examine opportunities and barriers, as perceived by federal laboratory personnel, to the commercial application of federally developed technology to the private sector, 2) to examine the perceptions of federal laboratory personnel regarding the 1986 Act, and 3) to use the information from the first two objectives to suggest ways to ease and enhance the ever challenging process of technology transfer.A survey of 479 federal lab personnel including both managers and scientists/engineers was conducted in support of the above objectives. Overall, the results of the study support the findings of previous research. Recommendations are offered to help make technology transfer and the implementation of the 1986 Act a success.

A STUDY OF FEDERAL TECHNOLOGY TRANSFER TO THE COMMERCIAL SECTOR

I. Introduction

This chapter contains a general background on the commercial technology transfer process and addresses the significance of the subject. The specific purpose of the research is stated, and the specific research objectives are listed. The scope and limitations of this study are also included.

Background

Technology has increasingly had an effect on the activities and relationships of business, government, and the individual. In 1986, the U.S. is expected to invest $118.6 billion in federal and non-federal research and development. Within only nine years, federal obligations for research and development in the United States have almost tripled, going from $23.45 billion in 1977 to an estimated $56.01 billion in 1986. Throughout those years the federal share has hovered very close to 50%. During this period, the Defense-related percentage of the federal share has grown from approximately 50% in the late seventies and early eighties to 63% in 1986. The 1986 Defense share equates to approximately $38 billion. The United States Air Force is allocated the major share, approximately $16 billion or 42%

(13:44,45). The result of these billions of dollars of research is advanced technology in many shapes, sizes, and of many uses.

Federally funded research and development by itself, however, does not result in inventions and innovations that immediately contribute to the civilian economy. Research and development results must first be transformed into products or services that can provide a benefit to the commercial sector. Since much of federal research and development is not directly related to commercial products, there must be a technology transfer process that acts as a catalyst in moving technology to the commercial sector (1:58; 7:131). For the purposes of this study, technology transfer was defined as the process by which federal research and development is transformed into products, processes, and services that can be applied to state and local government and private sector needs. Technology transfer, as defined in this study, is not associated with technology transition programs which are concerned with the development of technology for, and transition to, government programs or uses.

Since federal research and development expenditures involve such a large part of the Nation's manpower, dollar, and facilities resources, it is important for the health of our nation's economy that these resources be expended in as effective a manner as possible. Taking full advantage of the results of these expenditures should result in a higher standard of living, improved productivity, new industries and accompanying employment, strengthened national security, and enhanced competitiveness of the U.S. in the global economy. However, for our resources to be used most effectively, the U.S. must obtain the maximum return on its research and development expenditures without interfering with the specific objective of the research. Failing to maximize the use of our resources through effective technology transfer programs has contributed to the reduction of U.S. leadership in the global economy. Key industries such as steel, automobiles, and electronics have been affected. This problem has been recognized for some time. Fourteen years ago, then President Nixon in his address to Congess on Science and Technology (March 16, 1972) stated:

> 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. (10:3).

Specific Problem

The problem is that federally developed technology is not being transferred to the civilian sector at an acceptable rate. Research and development is no longer an acceptable end in itself. Federally funded research and development results must be translated into useful products, processes, or programs which satisfy public and private needs.

Purpose of Study

The purpose of this study was threefold. First, the study proposed to examine opportunities and barriers, as perceived by federal laboratory personnel, to the commercial application of federally developed technology to the private sector. Second, the study proposed to examine the perceptions of federal laboratory personnel regarding the Federal Technology Transfer Act of 1986. Finally, the study, based on comparisons and evaluations of the two points above, proposed to suggest methods for the more effective utilization of federal research and development.

Specific Objectives

This study addressed the technology transfer challenge faced by the federal labs. The identification of specific laboratories and laboratory personnel was kept confidential so that those involved in the research would be encouraged to respond openly. The overall objective of this research was to identify perceived opportunities and barriers to the commercial application of federal laboratory developed technology to the private sector, to better understand the perceptions of the laboratory personnel regarding recent technology transfer legislation, and to better understand the role of the government in the transfer of federally developed technology to the private sector. The following specific research objectives were directed toward the accomplishment of this goal:

1. determine the factors that laboratory personnel feel would facilitate technology transfer,

2. determine the barriers laboratory personnel perceive in transferring technology,

3. determine the opportunities laboratory personnel perceive in transferring technology,

4. determine laboratory personnel perceptions regarding the value of the Federal Technology Transfer Act of 1986 as an incentive to technology transfer,

5. determine the perceptions of laboratory personnel regarding consulting and joint research consortia as facilitators of technology transfer.

Scope of Study

This study examined the process of transferring federally developed technology to the private sector and the role of the government in this endeavor. Although resources dictated this study be limited to selected federal laboratories, it should lend insight to the commercial technology transfer problem at other federal laboratories as well. This study was conducted in cooperation with Dr. Robert Premus, former staff economist for the Joint Economic Committee, Congress of the United States and currently Professor of Economics and Director, Center for Industrial Studies, College of Business and Administration, Wright State University, Dayton, Ohio. This study was partially funded by a grant from the Ohio Board of Regents. Dr. Premus conducted a similar study which proposed to examine "high-tech" spin-off activity from Dayton area federal laboratory research and development activities. Dr. Premus' study examined the commercial sector perspective of the commercial technology transfer process from federal laboratories. This thesis examined the federal laboratory perspective regarding the same process. The results of both studies were combined by Dr. Premus in his research. The purpose of Dr. Premus' research project was fourfold:

1. to examine opportunities and barriers to the commercial application of federal technology as seen by the Dayton commercial sector,

2. to better understand the role of government and private sector organizations, such as the Chamber of Commerce, in encouraging commercial technology transfer,

3. to suggest an action oriented policy agenda for Ohio to pursue the benefits of federal research and development in Ohio and elsewhere, and

4. to suggest ways to link federal research and development to the growth and development of central cities in Ohio (14).

While Dr. Premus' study focused on Dayton's perceptions of the difficulties involved in federal technology transfer, the results of the study should be helpful to other urban communities throughout the U.S. The survey instruments for both studies were developed in a parallel effort to facilitate comparisons between the studies.

II. Literature Review

This chapter provides a review of the significant literature on technology transfer. The word "agency" is commonly used in the literature to refer to the department or agency level within the federal government; for example, the Departments of Agriculture, Commerce, and Defense or the Agency for International Development and the Environmental Protection Agency. This research will continue to use the word "agency" in the same manner. To the maximum extent possible this review will be presented chronologically. This chapter begins with the recognition that upper echelons of federal government have recognized the problem of obtaining an adequate return on investment from federal laboratory research for over two decades. The second section of Chapter II examines The Stevenson-Wydler Technology Innovation Act of 1980, one of the two most significant pieces of federal legislation addressing technology transfer. In the third, fourth, and fifth sections, three recent technology transfer studies are reviewed. The sixth section of Chapter II addresses the responsibilities of the commercial sector in the technology transfer process. Section seven reviews the Federal Technology Transfer Act of 1986, the second of the two most important federal legislative acts concerning technology transfer.

Recognition of the Problem

The federal government has made efforts to ensure the United States is receiving the best return possible from its laboratories for over two decades. In 1962, President Kennedy became concerned about the growth of spending for federal research and development. He asked the Director of the Bureau of the Budget to head a cabinet-level study of the situation. The result was the Bell Report. The report called for the following reforms:

1. agencies with laboratories as part of the organization needed to support world-class, cutting-edge research in their laboratories,

2. laboratory directors needed to have more discretionary authority, along with relief from agency micromanagement,

3. salaries for key laboratory scientists, engineers, and technicians needed to be raised to attract the most capable personnel.

Other advisory bodies endorsed these recommendations in a series of reports during the 1970's. Of the options proposed in these reports, one was that technology be transferred from the federal laboratories to state and local jurisdictions and to various public and private cooperative ventures, with the aim of speeding up the introduction of commercial products and techniques (5:42-43). In 1972, Dr. Hersman, Director of the National Science Foundation's Office of Intergovernmental Science and Research Utilization, condensed several technology transfer actions ongoing at the time. Three of the most important were:

1. President Nixon's message to Congress on Science and Technology which stated in part: "...I believe, the Government has a responsibility to transfer the results of its research and development activities to wider use in the private sector." (10:3). In the address President Nixon proclaimed an effort to improve the nation's economic well-being and quality of life. The President called for partnerships among federal laboratories, state and local governments, industry, universities, and other research organizations to apply federally sponsored research and development to domestic needs (5:44).

2. The report of the Committee on Intergovernmental Science Relations to the Federal Council on Science and Technology, which urges policies and mechanisms to increase the capacity of state and local governments for utilizing Federally developed technology and participating in formulating national research and development priorities.

3. A General Accounting Office recommendation for:

a. a Government Technology transfer policy which implements a formal, active technology transfer process,

b. Secretary of Defense policy and procedures to encourage greater transfer of defense technology to the civilian sector, and

c. focusing federal agency efforts in a technology transfer consulting team (10:2-3).

In 1971 the Federal Laboratory Consortium for Technology Transfer was organized by eleven Department of Defense (DOD) laboratories to facilitate the transfer of DOD developed technology to the civilian sector. In 1974 the Federal Laboratory Consortium for Technology Transfer expanded to include laboratories from other agencies (5:44). The consortium is currently a network of over 300 of the Federal Government's approximately 600 laboratories. The laboratories include material sciences, biotechnology, forestry, environment, medicine, energy, electronics, and agriculture. The Federal Laboratory Consortium for Technology Transfer is a network of laboratory representatives that assists state and local governments and the private sector in identifying the federal sources of technologies that may fulfill their interests or needs. The network can be accessed through the six regional coordinators or the individual representatives (16:3).

The Stevenson-Wydler Technology Innovation Act of 1980

Congress expanded upon the work of the Federal Laboratory Consortium for Technology Transfer and emphasized the commercialization of federal technology by passing Public Law 96-480, the Stevenson-Wydler Technology Innovation Act of 1980. This law made technology transfer activities an explicit part of the purpose of federal departments and agencies (17:47). Section 11 of the Act expresses congressional policy. Congress felt that

> It is the continuing responsibility of the Federal Government to to ensure the full use of the results of the Nation's Federal investment in research and development. To this end the Federal Government shall strive to transfer federally owned or originated technology to state and local governments and to the private sector (18:32).

In passing the act Congress recognized two key factors. The first was that no strong national policy concerning technology transfer had been developed. This lack of policy prevented the institutionalization of the technology transfer process. The second factor Congress recognized was that the federal laboratories were established to assist their parent agencies in meeting mission requirements. Without formal direction, technology transfer activities were secondary to endeavors which supported the agencies missions. A major objective of the Act was to show the intent of Congress to promote technology transfer activities at the federal agencies and laboratories (18:32). Several of the more important sections of the Stevenson-Wydler Technology Innovation Act are discussed below.

Section 5 of the Act established the Office of Industrial Technology. Duties of the office included:

1. determining the relationships of technological developments to the employment, productivity, and world trade performance of the United States,

2. identifying technological needs, problems, and opportunities, that if addressed, could make a significant contribution to the U.S. economy,

3. assessing whether the resources being allocated to domestic industrial sectors are likely to generate new technologies which are adequate to meet private and social demands for goods and services and to promote productivity and economic growth and,

4. providing that cooperative efforts be undertaken between the Office of Industrial Technology and the Department of Commerce to stimulate industrial innovation.

Section 6 of the Act established Centers for Industrial Technology. The objective of the centers is to enhance technological innovation through:

1. the participation of industry and universities in cooperative technological innovation activities,

2. the development of a generic research base,

3. the education and training of appropriate individuals in the technology innovation process,

4. the improvement of mechanisms for the dissemination of new technology among universities and industry.

Section 7 of the Act made it possible, under certain terms and conditions, for persons or institutions to apply for grants or to enter into cooperative agreements which assist technology transfer activities.

Section 11 encompassed the major thrust of the Act. It required each federal laboratory to establish an Office of Research and Technology Applications. Each laboratory, having a total annual budget exceeding $20 million, had to provide at least one professional individual to staff this office. Each federal agency which operated or directed one or more federal laboratories, had to make available not less than 0.5% of the agency's research and development budget to support the technology transfer function at the agency and its laboratories. The functions of the Research and Technology Applications Offices included:

1. preparing an assessment of each research and development project in which the laboratory is engaged which has potential for successful application in the domestic sector,

2. to provide and disseminate information on federal products, processes, and services having potential for application to the civilian sector,

3. to cooperate with and assist the Center for the Utilization of Federal Technology (CUFT) and other organizations which link the resources of that laboratory and the federal government to potential users in the civilian sector,and

4. to provide technical assistance in response to requests from state and local government officials (18).

Section 11 also established the Center for the Utilization of Federal Technology. Technology assessments from the Office of Research and Technology Applications are forwarded to the CUFT. The CUFT was placed under the National Technical Information Service (NTIS) in the Department of Commerce. NTIS had the ongoing function of collecting and disseminating information on all federally funded research and development projects. The CUFT was to:

1. serve as a central clearinghouse for the collection, dissemination and transfer of information on federal technology having potential application to the civilian sector,

2. coordinate the activities of the Offices of Research and Technology Applications of the federal laboratories,

3. utilize the expertise of the National Science Foundation and the existing Federal Laboratory Consortium for technology transfer,

4. receive requests for technical assistance from state and local governments and refer these requests to the appropriate federal laboratories (18).

The Stevenson-Wydler Technology Innovation Act of 1980 made a substantial contribution to the promotion of the transfer of federal technology to the domestic sector. However, experience and the results of several studies have shown that improvements to the Act are necessary. Many of the findings of these studies were incorporated into the first revision to the Stevenson-Wydler Technology Innovation Act of 1980. The first revision was the Federal Technology Transfer Act of 1986 which will be discussed in section seven of this chapter. The next three parts of Chapter II will examine three of the more recent technology transfer studies.

The Packard Report

This section of Chapter II has a dual focus. First, a study conducted by a panel of the White House Science Council is examined. The panel was headed by David Packard, chairman of Hewlett-Packard and former deputy secretary of the Defense Department. The study is commonly referred to as the Packard Report. Second, the results of a White House working group which reviewed how federal laboratories are carrying out the Packard Report's recommendations is summarized.

Early in 1982 George Keyworth II, the President's science advisor and director of the White House Science Council, chose David Packard to head a panel to review the technology transfer status at the federal laboratories. Keyworth instructed Packard to ask whether the nation is receiving an adequate return on the taxpayers' investment in the federal laboratories and whether the laboratories are helping to stimulate the industrial competitiveness of the U.S. After a year long review, Packard issued a report that called for increased interaction between the laboratories and commercial firms. The report accused some of the laboratories of working without clear purpose and inadequately contributing to the nation's good. The panel recommended the laboratories develop more alliances with universities and corporations and simplify government procedures.

In August 1983, President Reagan directed the Office of Science and Technology Policy and the Office of Management and Budget to lead an interagency effort to respond to the report. One of the working groups involved in this effort was the Working Group on External Interactions chaired by Frank McDonald, the Chief Scientist of the National Aeronautical and Space Administration. The group made the following recommendations:

1. agencies and laboratories should promote means by which U.S. industry can participate in identifying the nation's basic research needs,

2. the transfer of technology to private industry should be incorporated into the laboratory mission so as to provide management focus and a positive environment for technology transfer,

3. laboratories should involve industry in technology planning at the earliest appropriate time, and strengthen techniques to determine the commercial potential of new technology,

4. the authority of the laboratories should be extended to allow them to engage in a variety of cooperative research projects and to allow them to provide an incentive program for laboratory inventors, and

5. incentives and training programs should be developed at the laboratories to promote technology transfer and the commercialization of laboratory research results (3:42-47).

A review of section six in this chapter will reveal a close relationship among several of the working group recommendations and the changes made in moving from the Stevenson-Wydler Act to the Federal Technology Transfer Act of 1986. The next study to be reviewed followed the Packard Report and the subsequent Working Group on External Interactions by seven months. The conclusions of the working group and following study are consonant.

The Premus Study

This section of Chapter II reviews a study titled "The U.S. Climate for Entreprenuership and Innovation". The study was conducted at the request of the Joint Economic Committee, Congress of the United States. The authors were Dr. Robert Premus, former staff economist; Dr. Charles Bradford, assistant director and senior economist; George Krumbhaar, staff economist; and Wendy Schacht, Science Policy Research Division, Congressional Research Service. The study is based on a series of Joint Economic Committee hearings on entrepreneurship and innovation, chaired by Congressman Daniel E. Lungren (17:III). Chapter IV of the Premus Study is titled "Government Laboratories and Economic Development". The chapter examines technology transfer from federal government laboratories to the marketplace. This study recognizes that the challenge is to find ways to enhance the flow of technology and expertise from the federal laboratories to the commercial sector without sacrificing the laboratory mission. Much of the discussion in Chapter IV of the Premus Study is based upon expert testimony before the Joint Economic Committee in its August

7, 1984, hearing on the "Role of Government Laboratories in Regional Economic Development." The witnesses at the hearing were The Honorable Clarence Brown, Deputy Secretary, Department of Commerce; Colonel Paul J. Theuer, Commander and Director, Construction Engineering Research Laboratory, Champaign, IL; Dr. George Dacey, President, Sandia National Laboratories; Mr. Charles Miller, Lawrence Livermore Laboratory; and Dr. Edward Melecki, University of Florida. The Federal Laboratory Consortium for Technology Transfer and the National Aeronautics and Space Administration also contributed (17:41).

The study found that the Stevenson-Wydler Technology Innovation Act made a positive contribution to technology transfer. However, the study found some problems still unsolved. Deputy Secretary Brown felt that the laboratories do not perceive the Act as providing them with the authority to enter into transfer agreements with the private sector. Brown recommended that Congress pass further legislation to provide laboratories clear authority for the transfer of technology and for licensing decisions to be made at the laboratory rather than at the agency. Brown felt the laboratory mission should include activities to foster technology transfer. Theuer, Dacey, and Miller felt that Stevenson-Wydler did provide laboratories with clear authority to pursue the transfer of technology to the private sector. However, they felt that it did not provide the incentives within the laboratories to encourage technology transfer. Dacey also indicated that he felt it was management's responsibility to project the idea that technology transfer provides a positive and essential contribution to the laboratory mission. Additional suggestions were made concerning payment of royalties to the individual inventor once a technology has been successfully commercialized. Another suggestion recommended that royalties should go to the laboratory which transferred the technology. The recommendations from Chapter IV of the Premus Study are as follows:

1. provide a full-time professional staff position in the Office of Research and Technology Applications,

2. include technology transfer in management's job evaluations, job descriptions, and employee promotion policies,

3. establish awards within the laboratory for the successful completion of technology transfer, including compensation for the laboratory and individuals responsible for the successful programs,

4. establish conflict of interest rules and regulations regarding laboratory-industry collaboration (17:48-52).

As illustrated in section six of this Literature Review, several of the Premus Study recommendations closely parallel legislative actions taken that resulted in the Federal Technology Transfer Act of 1986. The following study differs from the preceding studies in that it concentrated primarily on Office of Research and Technology Applications staff perceptions of technology transfer at various federal laboratories.

Federal Laboratory Consortium Study

This study is titled "Interagency Study of Federal Laboratory Technology Transfer Organization and Operation". The study was conducted by the Federal Laboratory-Interaction Working Group of the Federal Laboratory Consortium chaired by Claire Sink, Morgantown Energy Technology Center, U.S. Department of Energy. The study was completed in May 1985. The study was intended as an organizational and operational analysis of transfer activities within the federal laboratories to identify any weaknesses or strengths. The membership of the working group included representatives from the Departments of Agriculture, Commerce, Defense, Energy, and the National Aeronautical and Space Administration. The working group used a survey instrument to baseline the Office of Research and Technology Applications technology transfer activities across federal agencies (6:1). Some of the major findings were:

1. Most laboratories have very few visitors, either U.S. or foreign.

2. The majority of respondents indicated that their controlling agencies have a formal, written technology transfer policy. However, most of the respondents indicated

that the specific labs they work for do not have a formal, written policy.

3. Lack of a formal, written agency technology transfer policy seemed to indicate little senior management support, less outreach activity, lack of appropriate resources for making technology transfer assessments, and a weak reward program for researchers.

4. Offices of Research and Technology Application from small laboratories (151-500 personnel) reported frequent interaction with the laboratory or agency director; however, Offices of Research and Technology Application from large laboratories (2,000 or more personnel) reported infrequent interaction with the laboratory director.

5. Department of Defense Offices of Research and Technology Applications view senior management as less supportive of their technology transfer activities than those same offices from the Department of Energy or National Aeronautical and Space Administration.

6. Over half of the respondents (57%) reported that barriers existed to effective technology transfer. The barriers were reported by the larger, more active Offices of Research and Technology Applications. The following barriers were reported by almost all of the 57%:

a. lack of funding,

b. lack of management support/interest or formal policy,

c. lack of sufficient personnel,

d. lack of time,

e. classified or restricted information,and

f. lack of contacts with technology users.

The following barriers were reported only by National Aeronautics and Space Administration respondents:

a. lack of awareness of the value of technology transfer (internal to the laboratory),and

b. outside forces push efforts into unworkable molds.

The majority of respondents that indicated classified or restricted information as being a barrier were from the Department of Defense (6:5-11).

The results of this study are generally in agreement with the above two studies, and included the following recommendations:

1. increase ongoing laboratory to industry interaction (visitors, research associates, advisory groups, conferences, etc.),

2. encourage teamwork among the Office of Research and Technology Applications, researchers, and laboratory management in technology transfer activities,

3. provide training for The Office of Research and Technology Applications staff,

4. establish supportive agency and laboratory technology transfer policy where it does not already exist,

5. improve management support of and participation in technology transfer activities,

6. increase The Office of Research and Technology Application's interaction with and access to the laboratory director, and

7. establish formal written criteria for making technology application assessments (6:2-3).

Commercial Sector Responsibilities

The majority of information available on technology transfer seems to indicate that the U.S. Government is at fault for the failure to obtain adequate transfer of federal laboratory technology to the commercial sector. However, there are those that feel a share of the burden should be shifted to the domestic sector. For example, in a year long pilot program on technology transfer, the Westinghouse Hanford Company found that most of the obstacles to transfer were not in the federal laboratories or universities but within the corporation. Westinghouse found the main obstacle to technology transfer within the corporation was a lack of market direction or incentive to grow. Aggressive divisions of the company were receptive to absorbing new technologies and ideas that would fulfill goals and objectives. Another obstacle was restricted strategic funding. A corporation technology transfer program can have no effect unless the corporate directors are willing to make the necessary expenditures. Ignorance of opportunity was yet another obstacle. People at all levels in the organization need to be educated about the existence of federal laboratory technologies and the opportunities that lie therein.

The final obstacle Westinghouse found was the "not invented here" attitude. Personalizing the technology transfer process was successful in reducing this attitude. Finally, Westinghouse found that using internal technology transfer officers and stressing the person-to-person contacts, both within the company and between the company and the transferor, was critical to the success of their program (11:394-395). The conclusions of this program correspond with the findings of George Heaton Jr., Principle Research Associate at the Massachusetts Institute of Technology Center for Policy Alternatives, and Herbert Holloman, Japan Steel Professor of Technology and Policy at the Massachusetts Institute of Technology. They found that although the government can help in the transfer of technology, this is fundamentally a process that companies, not the government, must enventuate. They postulated that few firms consciously realize and act on the potential of technology transfer from federal laboratories. Heaton and Holloman found that while many U.S. firms do not make good use of the technology available to them, other countries do. They found Japan to be an excellent example of a country that strongly encourages the transfer of technical knowledge from around the world into itself. The Japanese, in both public and private sectors, make a great effort to monitor new technical developments around the world and attempt to use them where appropriate. They are also aggressive and quick to adopt and exploit new ideas (8:6). These views are supported by others as well. Timothy Smith, a staff reporter for The Wall Street Journal found one U.S. Government scientist's experience with technology transfer to be particularly enlightening. The scientist published the results from his research on toxins which caught the eye of industrialists with a problem, and won a government citation for saving an industry. The industry was Japan's soy-sauce brewers and the award was the Third Order of the Rising Sun, given to the scientist on behalf of the Emperor of Japan. Smith reported that most American companies shun the laboratories, and the technology that comes out of them usually goes to foreign counties (15:35). Clifford Lanham, executive secretary of the Federal Laboratory Consortium for Technology Transfer believes "Private companies do not take seriously looking for new technology" at the federal laboratories (15:35). Futhermore, Mr. Charles Miller, during testimony before the Joint Economic Committee, Congress of the U.S., in its August 7, 1984, hearing on the "Role of Government Laboratories in Regional Economic Development", cited a study that showed that the two primary users of the National Technical Information Service were the Soviet Union and Mitsubishi (17:47-48)!

One should recognize that although federal laboratory technology transfer activities may be improved upon, a wealth of knowledge currently exists in massive data bases such as the aforementioned National Technical Information Service and the Center for Utilization of Federal Technology. This research effort is concerned with the commercial technology transfer process from the federal laboratories and, therefore, the above review has concentrated primarily on the federal issues. However, exposure to the above section, Commercial Sector Responsibilities, was made to show that technology transfer requires a bipartisan effort. The domestic sector must be much more aggressive in its pursuit of technology if the Federal Technology Transfer Act of 1986 is to meet its full potential. The next section reviews the 1986 Act.

The Federal Technology Transfer Act of 1986

This section of Chapter II reviews the major changes made to the Stevenson-Wydler Technology Innovation Act of 1980 which resulted in the Federal Technology Transfer Act of 1986. Note the relation of the changes to the above studies. The major changes are:

1. Section 3 - This section of the new law officially established the Federal Laboratory Consortium for Technology Transfer (19), an organization which existed for the previous fifteen years unchartered by the U.S. Government (3:44). Funding for the consortium was also provided for in the new law.

2. Section 4 - This section strengthened one of the most important parts of the Stevenson-Wydler Act, Section 11, Utilization of Federal Technology. It made "Technology transfer, consistent with mission responsibilities,...a

responsibility of each laboratory science and engineering professional.". A major change was the requirement that

> Each laboratory director...ensure that efforts to transfer technology are considered positively in laboratory job descriptions, employee promotion policies, and evaluation of the job performance of scientists and engineers in the laboratory (19).

3. Section 12 - This section granted each federal agency the power to permit the director of any of its government operated laboratories to enter into cooperative research and development agreements with: (a) other federal agencies; (b) units of state or local governments; (c) industrial organizations (including corporations, partnerships, limited partnerships,and industrial development organizations); (d) public and private foundations; (e) non-profit organizations; or (f) other persons. The agency may also permit the director of any of its laboratories to negotiate licensing agreements.

4. Section 13 - This section instructs each federal agency that spends more than $50 million per fiscal year for research and development in Government operated laboratories to develop and implement a cash awards program to reward its scientific, engineering, and technical personnel for:

> 1. ...inventions, innovations, or other outstanding scientific or technological contributions of value to the United States due to commercial applications or due to contributions to missions of the...Federal Government, or
>
> 2. exemplary activities that promote the domestic transfer of science and technology developed within the Federal Government and result in utilization of such science and technology by American industry or

business, universities, State or local governments, or other non-Federal parties (19).

5. Section 14 - This section provides that any royalties or other income received by a Federal agency from the licensing of inventions shall be retained by the agency whose laboratory produced the invention. The agency must then pay at least 15% of the royalties or other income to the inventor if the inventor was an employee of the agency at the time the invention was made. The remainder is then allocated to its laboratories with the major share going to the laboratory that was responsible for the invention (19).

Summary

The first section of this chapter showed that the technology transfer problem has been recognized for over two decades. High-level federal government interest was demonstrated by:

1. President Kennedy's request for a study of federal research and development which resulted in the Bell Report,

2. a 1972 General Accounting Office recommendation for a Government technology transfer policy which would implement a formal, active technology transfer process, and

3. the formation of the Federal Laboratory Consortium for Technology Transfer in 1971.

In the second section of this chapter, the major provisions of the first major piece of technology transfer legislation, the Stevenson-Wydler Technology Innovation Act of 1980, were reviewed.

The third, fourth and fifth sections of this chapter reviewed three technology transfer studies that followed the Stevenson-Wydler Act. The studies illustrated deficiencies in the early 1980's technology transfer process and made recommendations, some of which would be incorporated in the Federal Technology Transfer Act of 1986.

The above three sections of this chapter examined the federal issues involved in the technology transfer process. The sixth section of this chapter recognized that technology transfer is a bipartisan effort, and requires domestic sector participation to be successful. It demonstrated that a large amount of information currently exists on new technologies in Federal Government repositories. However, the sixth section showed that the primary users of this data is not the U.S., but foreign countries.

The final section of this chapter reviewed the product of the increased interest in technology transfer in the early 1980's, the Federal Technology Transfer Act of 1986. This legislation incorporated much of the changes in thought that had occurred since the passage of The Stevenson-Wydler Technology Innovation Act of 1980.

III. Methodology

This chapter describes the methodology that was used to satisfy the research objectives stated in Chapter I. The population from which the data was collected, the survey instrument which was used to collect data, the data collection plan, and the statistical tests which were used to analyze the data are described.

Population

The population of interest in this research consisted of the following categories of laboratory personnel:

1. scientific and engineering (S&E) and
2. laboratory management.

The large size of the population, approximately 1700 employees, suggested that a sampling technique was appropriate. Details of the sampling plan are described in the following section.

Data Collection Plan

Management support, perceived or real, and management thought concerning commercial technology transfer can strongly influence the success of technology transfer from any federal lab, in as broad a range as the Department of Agriculture to the Department of Defense. For this reason the population was stratified into two subpopulations. As mentioned in the "Population" section above, the population consisted of approximately 1700 individuals. The subpopulations of interest were:

1. scientific and engineering personnel which was comprised of approximately 1362 employees,

2. laboratory management personnel which consisted of approximately 333 individuals.

A confidence/reliability level of 95% ± 5% was used in computing sample sizes for the stratified sample. The figure 95% was the confidence coefficient and the 5% figure was the confidence interval. This confidence/reliability level means that if many samples of the same size and format were to be drawn from the same population, 95% or more of the confidence intervals of the samples, plus or minus five percentage points, would contain the true population mean. Therefore, the surveyor was 95% confident that the true population statistics were within the interval plus or minus five percentage points from his achieved sample statistics for each survey question (4:11,12). The formula used for computing the sample sizes for this study is included in Appendix A. The stratified sampling plan provided each individual in a selected subpopulation an equal and independent opportunity to be included in the sample.

Using the subpopulations from above and the sample size formula from Appendix A, the following sample sizes were derived:

1. scientific and engineering personnel: 300

2. laboratory management personnel: 179

The total sample size was 479. Four weeks were allowed for the return of the survey questionaires. This allowed adequate time for the respondents to consider their replies.

Survey Instrument

A survey questionnaire was used in this research to collect data from which to satisfy the research objectives. The questionnaire was developed in parallel with the questionnaire for Dr. Premus' study mentioned in Chapter I. If a question applied to the populations of both this research and Dr. Premus' study, it was structured in as similar a manner as possible to facilitate comparisons between the studies. The survey package included a cover letter, the objectives of this research, and the survey.

Part I of the questionnaire measured the following demographic attributes:

- current position
- level of education
- years of government employment
- employment status (civilian or military)

Part II of the questionnaire measured the respondent's perceptions concerning opportunities and barriers to technology transfer, specifically:

- barriers to technology transfer from the lab to the commercial sector
- consulting with private firms as a facilitator of technology transfer
- opportunities to increase technology transfer
- closer relationships with the local university system researchers
- the effect of a joint research consortium involving universities, federal labs,and industry on commercial technology transfer
- the value of company technology transfer liaison officers in facilitating the transfer of technology

Part III of the questionnaire measured the respondent's perceptions regarding the effect of the Federal Technology Transfer Act of 1986 as a facilitator of technology transfer, specifically concerning:

- cooperative research and development arrangements
- royalty payments to inventors
- royalty payments to laboratories

The questionnaire was administered in a mail survey. Although the personal interview provides greater control, the decision to use a mail survey was made due to the requirements to gather data in the most practical manner. The mail survey reached the population at a low cost, eliminated interviewer bias and gave respondents adequate time to consider their replies. A total of 479 survey questionnaires were mailed. This included 179 to management personnel and 300 to scientific and engineering personnel. The questionnaire is included in Appendix B. Please refer to the Appendix for the questions that were asked and to see how the responses were scaled.

Data Analysis

The computer program, Lotus 1-2-3, was used to analyze the data obtained from the survey questionnaire. Given that the sample size for this study was 479, the Central Limit Theorem was assumed to apply to this research. The Central Limit Theorem states that if random samples are drawn from a population, then, when the sample sizes are large (i.e. 30 or more in number), the sample mean is approximately normally distributed. The approximation will become more and more accurate as the sample size increases (12:191).

Existing research on the subject of commercial technology transfer and perceptions of the Federal Technology Transfer Act of 1986 are relatively undeveloped and still in the exploratory stage. Therefore, this study collected and described data in several broad categories to contribute to the establishment of a data base on technology transfer activities. Hopefully, this effort contributed to the maturation of knowledge concerning this subject and will allow future research to build upon the data base and use higher level statistics to establish statistically sound causal links.

The following statistical procedures were used in the analysis of data obtained from the survey questionnaire.

Frequency Distributions. The Lotus subprogram "Data Distribution" determined the frequency counts for each value. The Lotus subprogram "@AVG" determined the mean scores for each variable.

Hypothesis Testing for Nominal Data. This test was used for testing the hypothesis of no difference between two population proportions against the alternate hypothesis that there is a difference between the two population proportions. Throughout this study a significance level of 0.05 was used. The significance level is the probability that the researcher will, in error, reject the null hypothesis when it is true. If the observed value of the test statistic (see Appendix A) exceeds the critical value or is less than the negative of the critical value the null hypothesis is rejected. Rejection of the null hypothesis indicated the likelihood that there was a difference between the two population proportions. Failure to reject the null hypothesis indicated the likelihood that there was no difference between the two population proportions. This test only helps the researcher decide whether the population proportions are independent or related. The test did not indicate strength or direction of the relationship (9:216-218).

Hypothesis Testing for Ordinal Data. The Wilcoxon Rank Sum Test for large independent samples was used for testing the hypothesis of no difference between two sampled population probability distributions against the alternative hypothesis that there is a difference between the two sampled population probability distributions. If the observed value of the test statistic (see Appendix A) exceeds the critical value or is less than the negative of the critical value, the null hypothesis is rejected. Rejection of the null hypothesis indicated the likelihood that there was a difference between the two sampled populations. Failure to reject the null hypothesis indicated the likelihood that there was no difference between the two sampled populations. This test only helps the researcher decide whether the sampled populations are independent or related. The test did not indicate strength or direction of the relationship (2:740).

IV. Results and Analysis

This chapter presents the descriptive statistics and analysis of data collected by the survey questionnaires. Each of the 11 research questions is analyzed separately. The frequency distributions, mean scores or rankings, and statistical test results are presented for all questions except 5, 6, and 10. The length and detail of questions 5, 6, and 10 dictated that they be presented in summary fashion in this chapter. However, a detailed presentation of questions 5, 6, and 10 is available in Appendices C, D, and E respectively.

Presentation of Findings

The return percentages for the questionnaires are shown below:

Category	Number Mailed	Number Returned	Return Percentage
Total	479	160	33.4%
S&E	300	79	26.3%
Mgt	179	81	45.3%

The respondents were sorted "ex post" by educational degree (undergraduate/graduate or higher) and years of federal government experience (0-20 years and 21-40 years) for additional analysis. The "sample" sizes are as follows.

Degree	Number	%
Undergraduate	69	43.1
Graduate	91	56.9

Years Exp	Number	%
0-20	85	53.1
21-40	75	46.9

Part I: Demographic Information

This part of the survey questionnaire collected demographic information including current position, educational degree, workday activities, years of work experience in federal employment, and employment status.

Question 1. This question asked the respondents to identify their current position by choosing from six categories. The distribution of the respondents' job positions is as follows.

	Position	N	%
1.	Project Scientist/Engineer	79	49.4
2.	Branch Chief	19	11.9
3.	Division Chief	9	5.6
4.	Lab director/Deputy Director/ Chief Scientist	1	0.6
5.	Project/Contract Manager	21	13.1
6.	Other	31	19.4

Category 6 consisted entirely of management positions in the following categories: Group Chief, Supervisor, deputy positions, and staff positions.

Question 2. This question asked the respondents to indicate the highest degree they held. The distribution of educational degrees among the survey respondents is shown below.

By Experience in Years

	Total		0-20		21-40	
Degree	N	%	N	%	N	%
Post Doctoral	5	3.1	3	3.5	2	2.7
Doctoral	16	10.0	6	7.5	10	13.3
Masters	70	43.8	39	45.9	31	41.3
Undergraduate	69	43.1	37	43.5	32	42.7
Technical College	0	0.0	0	0.0	0	0.0

By Position (S&E/Mgt)

	Total		S&E		Mgt	
Degree	N	%	N	%	N	%
Post Doctoral	5	3.1	3	3.7	2	2.4
Doctoral	16	10.0	8	10.1	8	9.8
Masters	70	43.8	34	43.0	36	44.4
Undergraduate	69	43.1	34	43.0	35	43.2
Technical College	0	0.0	0	0.0	0	0.0

The majority of respondents (86.9%) held an undergraduate or masters degree. Thirteen percent had completed post-graduate work. Those respondents with 0-20 years experience had a slightly higher percentage of undergraduate and graduate degrees as compared to those with 21-40 years of experience. However, those respondents with 21-40 years of experience had marginally more post-graduate education completed. In summary, there is little difference in educational degrees held based on years of federal government experience. When considered by position, the distribution of degrees between scientists/engineers and managers is essentially equivalent.

Question 3. In responding to this question those surveyed were asked to allocate their workday activities into 4 areas. The mean results are shown below.

Activity	S&E	Mgt
In-House R&D	36.93%	8.26%
Support To Others	22.89%	23.44%
Contract Mgt	24.87%	23.51%
Overhead Activities	15.41%	43.60%

Scientists and engineers, on the average, spent more than twice the time on R&D than they did on overhead activities. Conversely, managers spent almost half of their time on overhead activities (administration, staff meetings, directing, etc.) and less than 10% on R&D. However, both managers and scientists/engineers spent almost exactly the same amount of time on support and contracting activities such as providing engineering support to System Program

Offices at the Aeronautical Systems Division (ASD), writing contracts, providing inputs to contracts, participating in both ASD and internal source selections, and monitoring contract performance.

Question 4. The respondents were asked to indicate the number of years they have been employed by the federal government. The distribution is shown below:

	Total		S&E		Mgt	
Years	N	%	N	%	N	%
5	25	15.6	22	27.8	3	3.7
10	29	18.1	24	30.3	5	6.1
15	14	8.8	8	10.1	6	7.4
20	17	10.6	7	8.8	10	12.3
25	20	12.5	7	8.8	13	16.0
30	37	23.1	5	6.3	32	39.5
35	13	8.1	3	3.7	10	12.3
40	5	3.1	3	3.7	2	2.4

Twenty-two and one half per cent of the scientists/engineers indicated they had 21-40 years of service while over two thirds (70.2%) of the managers were in the same range of service. The average length of government service for several work categories is shown below:

Category	Years
S&E	12.62
Mgt	23.44
Graduate	18.50
Undergraduate	17.56
All Respondents	18.10

On the average, scientists/engineers have approximately one half the number of years in federal employment as managers. Those surveyed holding graduate level or higher degrees, on the average, had approximately one more year of federal service than those with undergraduate degrees.

Question 4a. This question asked the respondents whether they were civilian or military. The civilian/military distribution of respondents is as follows.

	Number of Respondents
Civilian	160
Military	0

Part II: Technology Transfer Opportunities and Barriers

Question 5 investigated laboratory personnel perceptions regarding potential barriers to technology transfer. These potential barriers included the lack of incentives, poor communication with industry, and lack of private sector awareness. The sixth question examined lab perceptions of suggested technology transfer facilitators. Consulting on one's own time, increasing scientist/engineer funding, and providing monetary incentives for inventions were among the items reviewed. Question 6a provided those surveyed with an opportunity to suggest means of increasing the transfer of technology from federal labs to the commercial sector. Closer ties among federal labs and university researchers were examined in question 7 and 7a while questions 8 and 9 looked at joint research consortiums and private company technology transfer officers.

Question 5. This question listed conditions that the literature review revealed as potential barriers to technology transfer, and asked the respondents to indicate which they thought were major barriers in the transfer of technology from their laboratory to the commercial sector. The hypothesis test for nominal data mentioned in Chapter III (a test of population proportions) was applied to these data. The response distributions and percentages and results of the hypothesis tests are presented in Appendix C. A summary of the findings ("yes, the condition is a barrier" or "no, the condition is not a barrier") is shown below.

	Condition	Yes %	No %
1.	lab mission statement unclear	12.5	87.5
2.	lab mgt policies unclear	32.5	67.5
3.	lack of incentives	40.6	59.4
4.	classified research	45.0	55.0
5.	poor communication with industry	25.7	74.3
6.	lack of private sector interest	10.0	90.0
7.	lack of private sector awareness	23.1	76.9
8.	"red tape" for lab	34.4	65.6
9.	"red tape" for companies	12.5	87.5
10.	S&Es lack awareness of technology transfer role	51.9	48.1
11.	mgt lacks awareness of value of technology transfer	18.7	81.3

The respondents were given the opportunity to suggest conditions that they perceived as barriers. They are summarized by category below.

- excessive paperwork, budget exercises, reporting requirements
- lack of manpower
- lack of vision/risk taking on industry's part

Conditions 1, 6, 9 and 11 were clearly not considered to be barriers to technology transfer. Conditions 3, 4, and 10 had the strongest indications of being barriers to technology transfer. Conditions 2, 5, 7, and 8 were clustered around the 65% - 75% range; a weak indication that these conditions were not considered to be barriers. The hypothesis tests indicated that none of the groups differed significantly in their perceptions regarding the above conditions as barriers to technology transfer. Chapter 5, Figure 2 highlights the key technology transfer barriers.

Question 6. Those surveyed were asked to rate suggestions for facilitating technology transfer on a scale of "0" to "3" (low effectiveness), "4" to "6" (medium effectiveness), and "7" to "10" (high effectiveness). The hypothesis test for ordinal data mentioned in Chapter III (the Wilcoxon Rank Sum Test) was applied to these data (null hypothesis = no difference between the sampled population probability distributions). The mean score and percentage of respondents rating the facilitator as "low effectiveness" is provided for each suggested technology transfer facilitator. If the hypothesis tests indicated a significant difference in perceptions for any particular item, it is so indicated in column 4 below, and the group with the higher mean score is shown in column 5. More detailed information including response distributions is found in Appendix D.

	Suggested Facilitator	percent low	mean score	reject null	higher score
1.	consulting on own time	31.0	5.74	S&E/Mgt	S&E
2.	joint research consortium	6.8	7.41	None	N/A
3.	educate lab on technology transfer	38.0	5.63	Grad/Under	Under
4.	educate lab on ORTA	28.1	5.33	Grad/Under	Under
5.	more lab director/ mgt support	20.6	5.88	None	N/A
6.	increase ORTA funding	40.0	4.54	Grad/Under	Under
7.	increase S&E funding	19.4	6.06	Grad/Under	Under
8.	monetary incentives for inventions	13.8	6.74	S&E/Mgt	Mgt
9.	increase ORTA staffing	49.4	3.81	None	N/A
10.	agency policy if none	26.3	5.28	Grad/Under	Under
11.	lab policy if none	23.1	5.75	None	N/A
12.	ORTA interaction w/lab director	40.0	4.37	Grad/Under	Under
13.	ORTA interaction w/agency director	46.9	4.09	Grad/Under	Under
14.	notify by mailing list	35.6	4.99	S&E/Mgt Grad/Under 0-20/21-40	S&E Under 0-20
15.	internal reports on new technology	35.6	4.63	None	N/A
16.	support information requests	27.5	5.31	None	N/A

Two themes were apparent as a result of the analysis. The first was that significant differences existed between graduates and undergraduates concerning technology transfer education; (suggestion 3: educate the lab on technology transfer and suggestion 4: educate the lab on the ORTA). The second theme was the low mean scores on suggestions 6, 9, 12, and 13 which concerned the increase of ORTA funding, staffing, and interaction with the lab and/or agency director.

Regarding the first theme, in both cases the undergraduates average score was approximately one point higher than that of those holding a graduate degree or higher (suggestion 3: 6.29 to 5.12, suggestion 4: 5.86 to 4.92). The undergraduates appeared to place a higher value on technology transfer education than did the graduates. The undergraduates also differed significantly and assigned higher mean scores to suggestions 6, 7, 10, 12, 13, and 14 which were a) increasing ORTA funding, b) increasing scientist/ engineer funding, c) creating an agency policy on technology transfer if none exists, d) increasing ORTA interaction with the lab director, e) increasing ORTA interaction with the agency director, and f) notifying the private sector of available technology by a mailing list.

Suggestions 6, 9, 12, 13, and 15 were clustered around the 3.8 to 4.6 range; an indication that these conditions were not considered effective methods of facilitating technology transfer. The second theme concerns suggestions

6, 9, 12, and 13 which included the increase of ORTA funding, staffing, and interaction with the lab and/or agency director. These negative perceptions could result from a lack of knowledge concerning the role of the ORTA and technology transfer which might result in a negative reaction to the establishment or support of an office in the lab that, to those not informed about technology transfer, appears to not contribute to the lab mission or benefit lab employees. Another possible explanation is the reluctance of any part of an organization to give up its power or stand by passively while shifts in the organizational power base occur. In essence this is what would happen if the ORTA began to interact more closely with the lab/agency directors.

The hypothesis tests also indicated that scientists/engineers and management differed significantly in their perceptions on suggestions 1 (consulting on one's own time), 8 (monetary incentives for inventions), and 14 (notifying the private sector of available technology through a mailing list). In suggestion 1 and 14 scientists/engineers had the higher mean score. In suggestion 8 management had the higher mean score which may indicate that they recognized the indirect benefits they and the lab might receive as a resul of monetary motivation.

This research concludes that suggestions 2 (participating in a joint research consortium), 7 (increasing scientist/engineer funding), and 8 (monetary incentives for inventions) were considered especially beneficial to technology transfer. An important result of this analysis is that differences in perceptions do exist. Additional research is necessary to confirm these differences but nevertheless, they should be considered in the design and implementation of a technology transfer program. Chapter 5, Figure 1 highlights the key technology transfer facilitators.

Question 6a. This question asked the respondents to provide their own suggestions for facilitating technology transfer. The responses are summarized below.

- publish a tech brief/pamphlet summarizing available technology and listing focal points
- create formal technology transition plan
- educate personnel on technology transfer process
- make a technology transfer plan a contractual requirement for contractual research
- educate scientists/engineers on patent procedures
- consulting on own time or government time
- include technology transfer in performance appraisals of lab managers and scientists/engineers
- encourage and support technology transfer
- provide monetary awards
- use mailing list of new technologies
- participate in joint consortia
- educate lab personnel on technology transfer process

Although all of these suggestions are worthy of consideration, the most frequently mentioned suggestion was providing incentives and/or monetary awards. The next position consisted of four suggestions whose frequency of mention were almost equal. They are: a) publishing a tech brief/pamphlet summarizing available technology, b) consulting on one's own time or government time, c) encouraging and supporting technology transfer, and d) educating lab personnel on the technology transfer process. Participating in joint research consortia ranked next followed distantly by the other suggestions.

Question 7. This question asked those surveyed if they thought their laboratory would benefit from closer ties with the local university researchers. The hypothesis test for nominal data mentioned in Chapter III (a test of population proportions) was applied to these data and the results, as well as response distributions, are shown below.

Distributions and Percentages:

Closer Ties With Local Universities

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
Yes	64	81.0	64	79.0	67	78.8	61	81.3
No	15	18.9	17	21.0	18	21.2	14	18.7

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
Yes	71	78.0	57	82.6	128	80.0
No	20	22.0	12	17.4	32	20.0

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ * Reject
S&E/Mgt	1.96	-0.31	A
Grad/Under	1.96	0.73	A
0-20/20-40	1.96	0.40	A

* Failure to reject the null hypothesis meant that there were no statistically significant differences in perceptions among the groups.

Eighty per cent of the respondents felt that their lab would benefit from closer ties with the local university system researchers. The hypothesis tests resulted in a failure to reject the null hypothesis. This suggested that there was no statistically significant difference in perceptions between the groups regarding working closer with university system researchers.

Question 7a. This question asked the respondents to indicate which university departments they would work closest with. The respondents were asked to indicate all applicable responses. The distribution of responses is as follows. The "No" column indicates the number of respondents that would not work closely with that department. The "Yes" column indicates the number of respondents that would work closely with that department.

University Department	No	Yes
Mechanical Eng	88	72
Electrical Eng	81	79
Chemical Eng	126	34
Civil Eng	154	6
Computer Eng	103	57
Computer Science	105	55
Biomedical Science	157	3
Chemistry	128	32
Physics	112	48
Other	113	47

This research indicates that the following university departments would experience the most interaction with the subject laboratories: mechanical engineering, electrical engineering, computer engineering, computer science, and physics.

Question 8. Those surveyed were asked if they felt a joint research consortium involving the universities, federal labs, and industry would facilitate technology transfer. The hypothesis test for nominal data mentioned in Chapter III (a test of population proportions) was applied to these data. The results are shown below along with response distributions and percentages. The respondents were also given the opportunity to express why they felt a consortium would or would not facilitate technology transfer. These responses are summarized below.

Distributions and Percentages: Joint Research Consortium

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
Yes	67	84.8	64	79.0	71	83.5	60	80.0
No	12	15.2	17	21.0	14	16.5	15	20.0

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
Yes	74	81.3	57	82.6	131	81.9
No	17	18.7	12	17.4	29	18.1

Hypothesis Test Results

	Critical Statistic	Test Statistic	Accept/ * Reject
S&E/Mgt	1.96	-0.95	A
Grad/Under	1.96	0.21	A
0-20/20-40	1.96	-0.57	A

* Failure to reject the null hypothesis meant that there were no statistically significant differences in perceptions among the groups.

The majority (81.9%) felt that a joint research consortium involving the universities, federal labs, and industry would facilitate technology transfer. The hypothesis tests suggested that none of the groups differed significantly in their perceptions regarding working closer with university system researchers.

Comments regarding the value of joint research consortia in facilitating technology transfer are summarized as follows.

Affirmative Responses

- would enhance communication
- would be able to work together on projects/pool resources/reap benefits of synergism
- overcomes the "not invented here" syndrome
- opens minds/reduces narrow frame of reference
- industry could learn of new technology sooner
- one on one interaction would help greatly
- possible researcher rotation

Negative Responses

- too small a gathering; reports to a large number of companies would be better
- would be another bureaucracy
- would impact on R&D time
- legal problems difficult to overcome

Question 9. A company technology transfer officer acting as a liaison between the company's technological needs and the technology available at federal labs has the potential for facilitating technology transfer. This question asked the population sample if they felt such an officer would indeed improve the technology transfer process. The hypothesis test for nominal data mentioned in

Chapter III (a test of population proportions) was applied to these data. The response distributions and percentages and results of the hypothesis tests are shown below. Those surveyed were also given the opportunity to express why they felt a company technology transfer officer would or would not facilitate technology transfer. These responses are also summarized below.

Distributions and Percentages: Technology Transfer Officer

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
Yes	45	57.0	49	62.0	48	56.5	46	54.1
No	34	43.0	32	38.0	37	43.5	29	45.9

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
Yes	50	54.9	44	63.8	94	58.8
No	41	45.1	25	36.2	66	41.2

Hypothesis Test Results

	Critical Statistic	Test Statistic	Accept/ * Reject
S&E/Mgt	1.96	0.45	A
Grad/Under	1.96	1.13	A
0-20/20-40	1.96	0.62	A

* Failure to reject the null hypothesis meant that there were no statistically significant differences in perceptions among the groups.

Slightly more than half (58.8%) of the respondents felt that a company technology transfer officer acting as a liaison between the company's technological needs and the technology available at their lab would not facilitate technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding company technology transfer officers.

The summary of comments regarding the respondents' perceptions of the value of technology transfer officers follows.

Affirmative Responses

- the officer would consider the business "big picture" rather than narrow technological interests
- could identify specific needs
- enhance communication
- serves as a focal point
- a familiar face will get better responses
- will help overcome the "not invented here" syndrome
- reduce the lab effort required for technology transfer
- full time liaison would probably do better than a researcher/manager with additional technology transfer duties

Negative Responses

- more red tape/bureaucracy
- need more researcher to researcher contact
- could cause conflict of interest problems such as perceived differences in the support received from a lab in the transfer of technology to two or more different companies

Part III: The Federal Technology Transfer Act of 1986

This section of the survey collected data regarding the respondents perceptions of selected provisions of the Federal Technology Transfer Act of 1986. These provisions addressed a) cooperative R&D arrangements, b) licensing agreements, c) funds, services, and property transfers,

d) granting patent licenses, e) paying inventors 15% royalties, and f) paying the balance of the royalties to the lab.

Question 10. This question listed provisions of Public Law 99-502 (Federal Technology Transfer Act of 1986) and asked the respondents to rate the value of each on a scale of "0" to "3" (low), "4" to "6" (medium), and "7" to "10" (high) as:

(A) an incentive to scientists and engineers in facilitating technology transfer and

(B) an incentive to lab management in facilitating technology transfer.

The mean score and percentage of respondents rating each provision as "low effectiveness" is provided. The hypothesis test for ordinal data mentioned in Chapter III (the Wilcoxon Rank Sum Test) was applied to these data. If the hypothesis tests indicated a significant difference in perceptions regarding any particular item, it is so indicated in column 4 and the group with the higher mean score is again shown in column 5.

Provision	percent low	mean score	reject null	higher score
1. COOPERATIVE R&D ARRANGEMENTS				
incentive for S&E	24.1	5.74	None	N/A
incentive for Mgt	17.5	6.11	None	N/A
2. LICENSING AGREEMENTS				
incentive for S&E	21.3	5.64	None	N/A
incentive for Mgt	26.9	5.36	None	N/A
3. FUNDS, SERVICES, AND PROPERTY TRANSFERS				
incentive for S&E	22.5	5.80	None	N/A
incentive for Mgt	21.1	5.82	None	N/A
4. GRANTING PATENT LICENSES				
incentive for S&E	16.25	6.73	S&E/Mgt 0-20/21-40	S&E 0-20
incentive for Mgt	31.25	4.96	None	N/A
5. PAY INVENTORS 15% ROYALTIES				
incentive for S&E	5.6	8.34	None	N/A
incentive for Mgt	32.5	4.90	None	N/A
6. BALANCE OF ROYALTIES TO LAB				
incentive for S&E	20.6	5.92	S&E/Mgt	S&E
incentive for Mgt	8.1	7.56	Grad/Under	Under

Approximately 32% of the respondents gave scores in the "low effectiveness" range for provisions 4 and 5 (granting of patent licenses and payment of 15% royalties to inventors) when considered as incentives for management. In fact, among all the incentives that were considered, these two provisions were the least effective when evaluated as incentives for management. However, the same two provisions ranked much higher when considered as incentives for scientists/engineers. With mean scores of 6.73 and 8.34 respectively, provisions 4 and 5 were clearly considered to be incentives to scientists/engineers in facilitating technology transfer.

Provisions 1, 2, and 3 had mean scores ranging from 5.36 to 6.11 as incentives for both scientists/engineers and management. Approximately 20% of the respondents rated these provisions in the "low effectiveness" range. Provision 6 had a score of 5.92 when considered as an incentive for scientists/engineers. This suggests that provision 6 is perceived to be of medium effectiveness by the sample population.

The hypothesis tests indicated that graduates and undergraduates differed significantly in their perceptions regarding the above conditions in one case. The undergraduates considered payment of royalties to the labs to be a stronger incentive to management than did respondents with graduate degrees. The hypothesis tests also indicated that scientists/engineers and management differed significantly in their perceptions two times. In both cases scientists/ engineers had the higher mean score. When considered as an incentive for scientists/engineers, both granting patent licenses and paying royalties to the lab were considered to be stronger incentives to technology transfer by scientists/ engineers rather than management. In one case (granting patent licenses, incentive for S&E) the 0-20/21-40 years of experience groups differed significantly with the 0-20 group assigning the higher mean score. Chapter 5, Figure 3 highlights the respondents perceptions in graphical form.

An important result of this analysis is that differences in perceptions do exist. Although additional research is necessary to confirm these differences, they should be considered in designing an implementation program for the Federal Technology Transfer Act of 1986.

Question 11. This question asked the respondents to provide advice on what they feel needs to be done to make technology transfer a success. Their responses are summarized below.

- encourage researchers and other contributors
- on contractual research use large mailing lists for final reports
- open lines of communication
- use greater monetary incentives
- set up meetings among key government/industry/university personnel from local area to establish a joint plan
- establish a regularly published technology summary

- establish a point of contact in specialty areas
- increase lab to industry researcher interaction
- educate researchers on patent filing procedures; publicize researcher benefits from patents
- have strong leadership at the ORTA level via lab director support
- do not create more paperwork
- a lot of R&D is done under contract; investigate the data rights issue
- address the "not invented here" syndrome
- address the potential for conflict of interest
- commercial needs must be known to labs

Although all of these suggestions are worthy of consideration, the three most frequently mentioned were: a) encourage researchers and other contributors, b) use greater monetary incentives, and c) do not create more paperwork. Condition "a" seems to indicate that many lab personnel are seeking positive reinforcement for their efforts. This could include management support of all types, a reward system that offers desirable "bonuses", a pat on the back, and promotions. The suggestion of greater monetary incentives as a method of enhancing the movement of technology from federal labs to the private sector is reflected in the Federal Technology Transfer Act of 1986 via royalty payments to individuals and labs. Hopefully, this will go a long way toward satisfying this perceived need for greater monetary incentives. Although the 1986 Act addresses this issue, federal labs should still examine their overall incentive program for adequacy. The third suggestion, "do not create more paperwork", appears to indicate that one of the conditions for successful technology transfer is a process or program that is as streamlined as possible. A minimum of forms, reviews, and briefings would appear to encourage those in the "trenches" to engage in the transfer of a technology to the commercial sector. A streamlined program would also have less negative impact on the currently existing lab mission.

V. Conclusions and Recommendations

Conclusions and recommendations are provided for consideration by federal government planners, policymakers, and federal laboratories as they attempt to comply with the Federal Technology Transfer Act of 1986. The result of these combined efforts will hopefully be a more efficient and effective technology transfer process, which could strengthen the global competitiveness of U.S. industry.

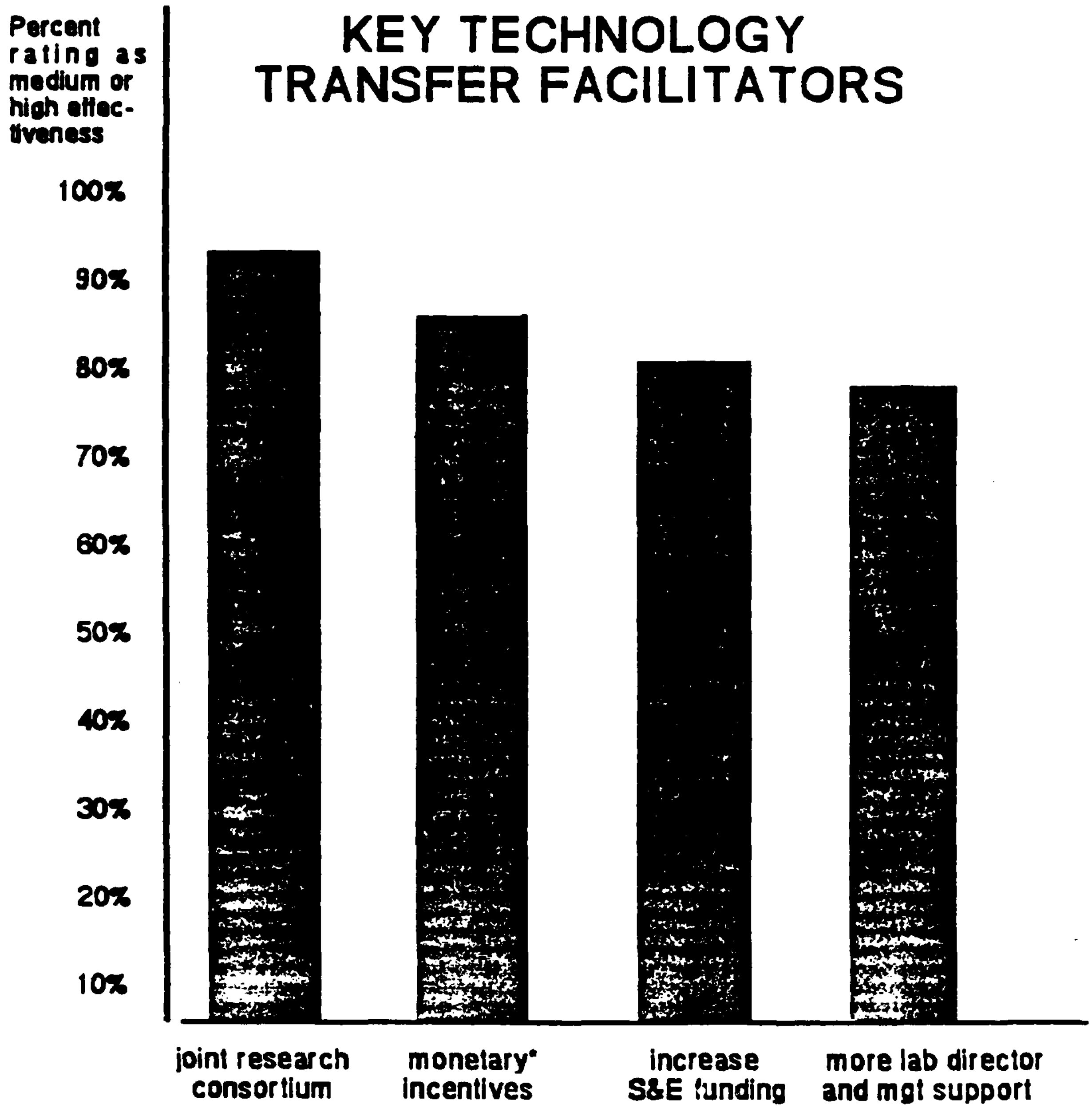
Conclusions

The data analysis that was detailed in Chapter 4 provided the basis for drawing conclusions. However, other information presented in this research, such as respondent comments, was used to make inferences about technology transfer, federal labs, and the Federal Technology Transfer Act of 1986. Overall, this research supported the findings presented in Chapter II, Literature Review. The conclusions of this research are summarized below.

Barriers. The research concludes that the lab mission statement, lack of private sector interest, too much "red tape" for the private sector, and lab management lacking awareness of the value of technology transfer are clearly not considered to be barriers to technology transfer. Lab management policies, poor communication with industry, lack of private sector awareness, and too much "red tape" for labs were also not considered to be barriers. Approximately 50% of the respondents said "yes, the condition is a barrier" and 50% answered "no, the condition is not a barrier" to the following conditions: the lack of incentives, the classified nature of some research, and scientists/engineers lacking awareness of the role of technology transfer. Therefore, it is inconclusive whether these conditions should be considered either as barriers or non-barriers. The respondents were given the opportunity, through voluntary open-ended comments, to suggest other barriers and they are: excessive paperwork, frequent budget exercises and reporting requirements, and lack of manpower.

Facilitators. The research concludes that the respondents felt joint research consortia, increasing scientist/engineer funding, closer ties with local university researchers, and monetary incentives for inventions were clearly considered to be methods of facilitating technology transfer. The following suggestions were perceived to be of medium effectiveness as facilitators of technology transfer: consulting on one's own time, educating lab personnel on technology transfer, educating lab personnel on the ORTA, more lab director and management support, creating an agency technology transfer policy if none exists, creating a lab technology transfer policy if none exists, using a mailing list to notify the private sector of available technology, and the use of technology transfer officers by private companies. Increasing ORTA funding, increasing ORTA staffing, increasing ORTA interaction with the lab director and agency director, and internal reports on new technology were not considered by the respondents to be effective methods of facilitating technology transfer. The respondents also suggested other facilitators. They are as follows: publishing a tech brief/pamphlet summarizing available technology and listing focal points, consulting on government time, educating scientists/engineers on patent procedures, making technology transfer plans contractual requirements on R&D performed under contract, using large mailing lists for final reports on contractual research, setting up a meeting among key government/industry/university personnel from the local area to establish a joint plan, investigating the data rights issue on contractual R&D, and addressing the potential for conflict of interest.

Public Law Perceptions. This section presents the conclusions regarding the respondents perceptions of the Federal Technology Transfer Act of 1986. The following provisions of this Act were considered to be incentives for both scientists/engineers and management in facilitating technology transfer: cooperative R&D arrangements; licensing agreements; funds, services, and property transfers; and transferring the balance of inventor royalties (after paying inventors 15%) to the laboratory. Granting patent licenses and paying inventors 15% of the royalties were both clearly considered by the respondents to be incentives for scientists/engineers. However, the same two provisions were considered by the respondents to be marginal incentives for lab management. The following three figures highlight the most significant findings of this research. The key facilitators of, and barriers to technology transfer are shown in the first two figures, and the final figure indicates perceptions about the effectiveness of various provisions in the 1986 technology transfer legislation.

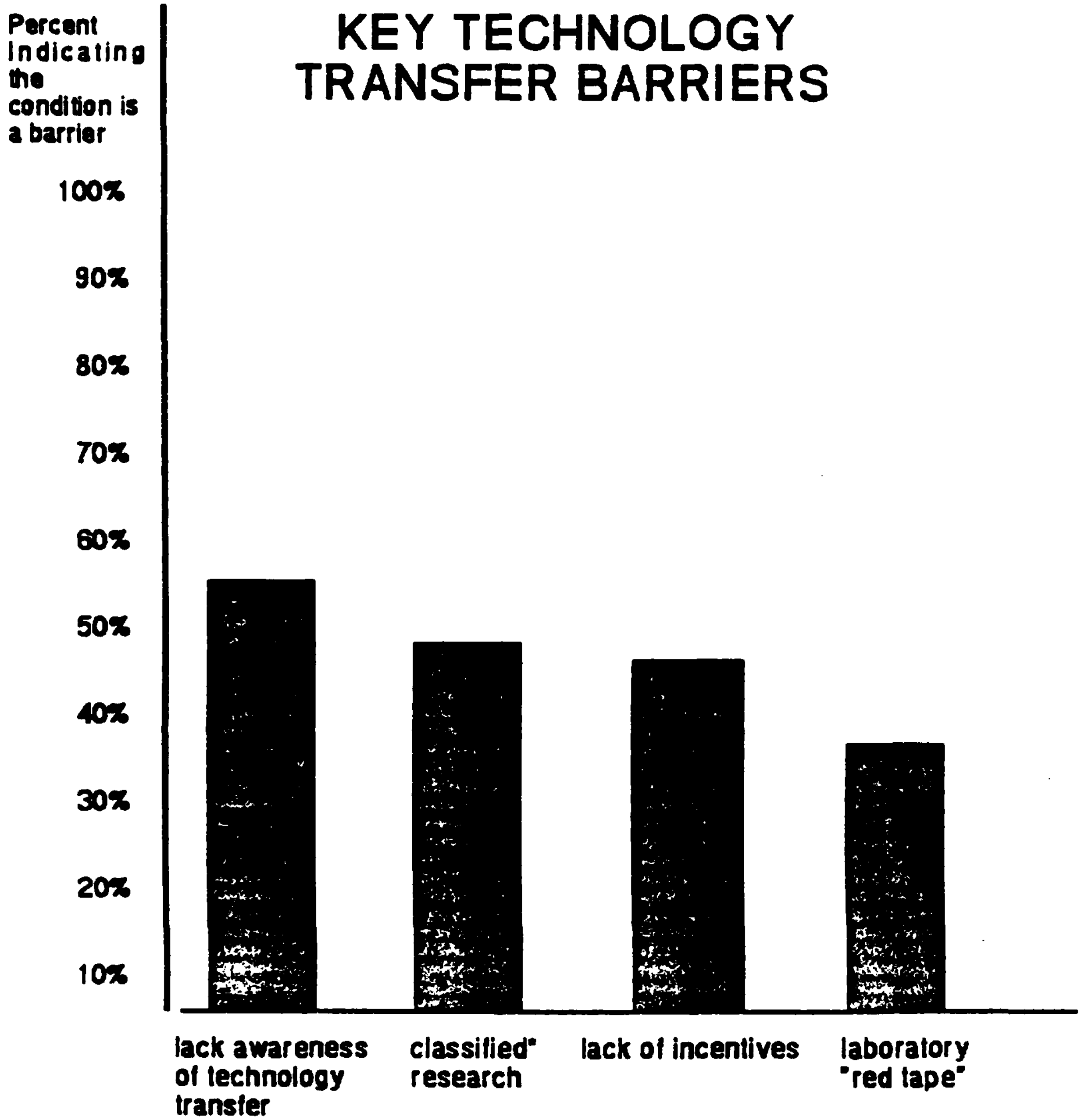


CONDITIONS

The above conditions were perceived by the respondents to be the greatest facilitators of technology transfer.

*Lack of incentives was a Key Barrier (see Figure 2).

Figure 1. Key Technology Transfer Facilitators



CONDITIONS

The above conditions were perceived by the respondents to be the greatest barriers to technology transfer.

*The condition "classified research" may be a barrier at Department of Energy or Defense labs but would probably not be a barrier at Forestry or Agriculture labs.

Figure 2. Key Technology Transfer Barriers

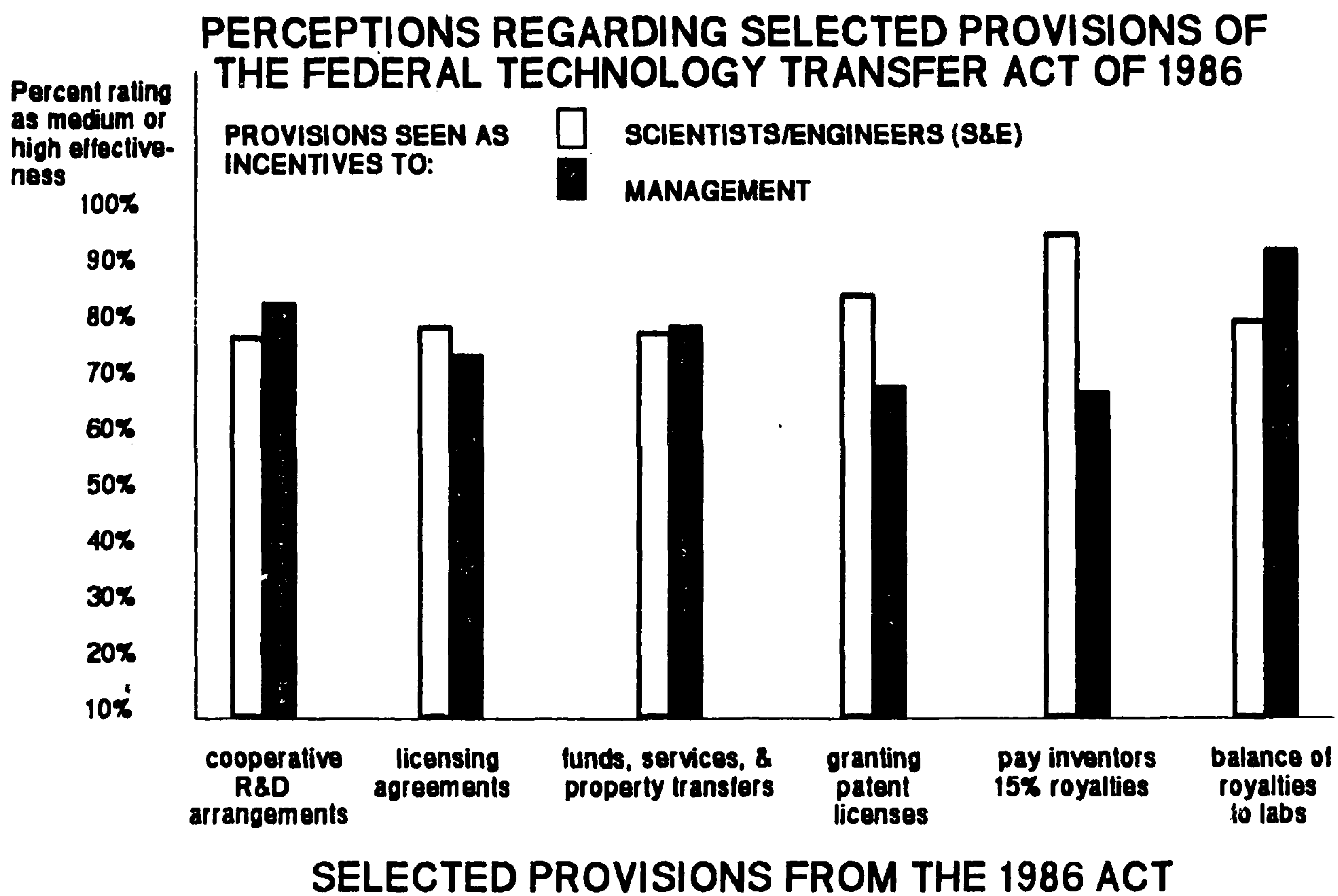


Figure 3. Perceptions Regarding the Effectiveness of Selected Provisions of the Federal Technology Transfer Act

Recommendations

The recommendations listed below are offered for consideration.

1. Consider taking action to make industry more aware of available technology. Industry needs to be educated concerning the National Technical Information Service, the Federal Laboratory Consortium, and other such organizations. This should probably be a coordinated effort headed by the Department of Commerce. However, federal laboratories should consider supplementing this with their own specific/local efforts such as publishing a pamphlet that summarizes new technologies or publicizing focal points for specific areas of research.

2. The rights of the Government to data and the cost to obtain those rights should be investigated to ensure that contractual R&D is not forgone as an opportunity to transfer technology. The wide variety of industry and government agencies involved (from agriculture to space) indicate that this should probably be worked by each agency or department. The large benefits for the private sector that can result from technology transfer should make industry amenable to participating in joint conferences on the data rights issue. An assembly of representatives familiar with technology transfer and the 1986 Act should be able to arrive at a mutually beneficial solution regarding data rights.

3. Investigate the conflict of interest issue. This should probably be worked at agency/department levels with

strong input from their labs. This needs to be clarified before any consulting or strong synergism can occur among labs, universities, and industry.

4. Federal labs should consider investigating their researchers cognizance regarding patent filing procedures. If the researchers are not aware of the opportunities that exist for personal and private sector gain through patenting their work they may fail to file for patents and potentially reduce the transfer of technology from their lab.

5. Agency/department planners need to provide interim guidance to their labs as soon as possible. This should reduce the uncertainty surrounding the major changes in the 1986 Act and promote uniformity and confidence within the agency/department during the early stages of implementation. The interim guidance should be followed as quickly as possible by implementing policy, directives, and regulations. This direction should be a result of a planning effort that involves active participation by each of the labs within the agency/department. The participants should recognize that the labs within any agency/department may have very diverse functions and implementing guidance should allow for tailoring.

6. Labs should find what the agency/department planners are doing in terms of implementing the Federal Technology Transfer Act of 1986. The labs should get involved in this planning effort as early as possible and take a proactive stance.

7. The federal labs should consider sharing their plans for implementing policy regarding the 1986 Act. This should allow good ideas concerning implementation of a technology transfer plan to be adopted by all who can use them or tailor them to specific applications.

8. After the labs receive policy/direction from their agency/department heads and have implemented a technology transfer plan, the labs should consider periodic monitoring of the knowledge levels and perceptions concerning technology transfer and the labs technology transfer plan. This should be an effective way of identifying opportunities for more effective and efficient technology transfer.

9. Technology transfer plans should be as streamlined as possible. Federal labs are manned to perform their particular mission and technology transfer is now an additional requirement without additional manning. In order to reduce/eliminate the negative impact on the lab's mission, the technology transfer plan should be as efficient as possible using existing systems to the maximum extent possible.

10. Differences in perceptions between scientists/engineers and management, or any other groups, should be taken into account when implementing a technology transfer plan. If one group perceives part of the plan negatively, and the other group perceives it positively, lab management should identify the reasons for the differences in perceptions and take positive corrective action to avoid the undermining of what might otherwise be an effective technol-

ogy transfer plan.

11. Federal labs should consider taking the lead in organizing joint research consortia and using the opportunity to benefit from the 1986 Act.

12. Federal labs should examine their incentive structure and consider implementing a more aggressive plan for both management and researchers. This should be done in consonance with the provisions of the 1986 Act.

13. Actions to increase the staffing, funding, or interaction with the lab director of the ORTA were not perceived as facilitating technology transfer by the majority of the respondents. Federal labs should pay close attention to how their ORTA's are perceived for the ORTA is a key position and can have great influence on technology transfer if properly staffed and given proper authority. If the ORTA is perceived negatively lab management should identify the reasons and take positive action to correct the situation. The negative perceptions could result from a lack of knowledge concerning the role of technology transfer and the ORTA, or perhaps from a perception of the ORTA needing resources that might otherwise be available for researchers and management.

14. The 1986 Act has numerous changes from the Stevenson-Wydler Technology Innovation Act of 1980. Federal laboratories should inform their employees of the purpose of the 1986 Act and the role of the lab in implementing technology transfer to avoid negative perceptions that might

result from lack of knowledge and the possibility of technology transfer being relegated to "additional duty" status.

Editorial Remarks by the Author

In the concluding remarks, the author wishes to note several additional observations that are believed to be important determinants of success in government technology transfer endeavors. As they were not derived directly from the survey results of this research, the observations must be acknowledged as the opinions of the author (however, these opinions are supported by the literature from related fields of organizational behavior and management).

As the implementing arm of this legislation (where the "rubber hits the road"), the nation's federal laboratories cannot proceed effectively without clear guidance, incentives for compliance, and the resources necessary for compliance (namely money and people). The research has already discussed issues related to guidance. In summary, while the legislation provides general guidance, the labs need another level of guidance - specific implementation guidance. The labs need clear direction complete with evaluation criteria that enable lab directors to know if they are meeting technology transfer goals. The identification of incentives and their role in promoting technology transfer has already been adequately discussed.

The remaining discussion will focus on the role of adequate resources, mechanisms for providing high-level visibility into the process, and organizational changes that are needed to promote successful technology transfer programs. Federal labs cannot be realistically expected to aggressively pursue technology transfer "out of their own pockets". Money and people are needed to "make these programs happen". The establishment of the ORTA was a good first step. However, a single ORTA representative, buried three layers deep in the organization, will likely find it difficult or impossible to ever fully satisfy the intent of the technology transfer legislation. Adequate manpower must be assigned to a clearly defined technology transfer mission. These people must have (or gain) expertise in what makes technology transfer work successfully, <u>and</u> their performance appraisals must reward them for their efforts in this area. If labs are expected to meet these responsibilities from existing manpower, the job will most likely take on a counterproductive "additional duty" status.

Another critical aspect of resources is adequate money to help the program gather enough momentum to become self-supporting. Once underway, technology transfer programs should generate royalties that can be shared between the inventor and the lab. However, initial seed money may be necessary to get the program underway. The same philosophy has been applied to the Air Force's Technology Modernization Program, now known more generically as the Industrial Modernization Incentive Program. It may even be possible to repay the seed money from royalties during the first few years of the program. In any event, the labs should receive financial help to initiate these programs.

Next, there must be some mechanism for assuring high-level visibility into the progress of these programs <u>without</u> creating burdensome paperwork and "fill-in-the-square" reports. The importance of top level interest and support during the implementation of any new program is well established in the literature across many academic disciplines. However, one of the most significant barriers to technology transfer identified by this research was the fear that involvement in these projects would result in a lot of uneconomical and "gratuitous" reporting requirements. Visibility must be achieved through a relatively simple process that is handled primarily by the tech transfer experts rather than the scientists who are actually doing the work.

Finally, at least until the technology transfer mission becomes accepted and institutionalized in the organization, someone who is charged with meeting technology transfer goals must have direct access to the Lab Director. If not, the person(s) charged with technology transfer responsibility may be stymied by middlemen who do not understand the program and more importantly, have no vested interest in its success.

Appendix A: Statistical Formulas

Sample Size Formula

$$n = \frac{N(z*z)*p(1-p)}{(N-1)*(d*d)+(z*z)*p(1-p)}$$

where:

n = sample size
N = population size
p = maximum sample size factor (0.50)
d = desired tolerance (0.05)
z = assurance factor for 95% confidence level (1.96)

Test statistic for the Wilcoxon Rank Sum Test for Large Independent Samples

$$z = \frac{Ta-[(n1(n1+n2+1))/2]}{[n1*n2(n1+n2+1)/12]}$$

where:

Ta = sum of ranks of first sample
n1 = size of first sample
n2 = size of second sample

Test Statistic for the Hypothesis Test of Proportions

$$z = \frac{(p1-p2)-(P1-P2)}{s}$$

where:

p1 = first observed sample proportion
p2 = second observed sample proportion
P1 = first population proportion
P1 = second population proportion
s = standard error of the difference between independent sample proportions

Appendix B: Survey Questionnaire

USAF SCN 87-35

A SURVEY OF FEDERAL TECHNOLOGY TRANSFER

TO THE COMMERCIAL SECTOR

PART I
PERSONAL CHARACTERISTICS

1. WHICH OF THE FOLLOWING BEST DESCRIBES YOUR CURRENT POSITION?

   ______ PROJECT SCIENTIST/ENGINEER

   ______ BRANCH CHIEF

   ______ DIVISION CHIEF

   ______ LAB DIRECTOR/DEPUTY DIRECTOR/CHIEF SCIENTIST

   ______ PROJECT/CONTRACT MANAGER

   ______ OTHER (please explain) ____________________________

   ____

2. WHAT IS THE HIGHEST DEGREE YOU HOLD?

   ______ POST DOCTORAL

   ______ DOCTORAL

   ______ MASTERS

   ______ UNDERGRADUATE

   ______ TECHNICAL COLLEGE

3. WHAT PERCENTAGE OF YOUR TIME IS SPENT IN THE FOLLOWING ACTIVITIES?

______ IN-HOUSE R&D ______ CONTRACT MANAGEMENT

______ SUPPORT TO OTHERS ______ OVERHEAD ACTIVITIES

4. HOW MANY YEARS OF WORK EXPERIENCE DO YOU HAVE IN FEDERAL GOVERNMENT EMPLOYMENT?

______

4a. WHAT IS YOUR EMPLOYMENT STATUS?

______ CIVILIAN ______ MILITARY

PART II
TECHNOLOGY TRANSFER OPPORTUNITIES AND BARRIERS

5. IN YOUR OPINION, WHAT ARE THE MAJOR BARRIERS TO TECHNOLOGY TRANSFER FROM YOUR LABORATORY TO THE COMMERCIAL SECTOR? (more than one response may be appropriate)

______ LAB MISSION STATEMENT UNCLEAR

______ LAB MANAGEMENT POLICIES UNCLEAR

______ LACK OF POSITIVE INCENTIVES TO EMPLOYEES

______ CLASSIFIED NATURE OF RESEARCH

______ LACK OF ADEQUATE CHANNELS OF COMMUNICATION WITH INDUSTRY

______ LACK OF INTEREST ON THE PART OF AMERICAN INDUSTRY

______ LACK OF AWARENESS ON THE PART OF AMERICAN INDUSTRY

______ TOO MUCH RED TAPE FOR LAB PERSONNEL

______ TOO MUCH RED TAPE FOR COMPANIES THAT WANT TECHNOLOGY

_____ PROJECT SCIENTISTS/ENGINEERS LACK AWARENESS OF THE ROLE OF TECHNOLOGY TRANSFER

_____ LAB MANAGEMENT LACKS AWARENESS OF THE VALUE OF TECHNOLOGY TRANSFER

_____ OTHER (please explain) ______________________

____

____

____

6. FOLLOWING ARE SEVERAL SUGGESTIONS FOR FACILITATING TECHNOLOGY TRANSFER. ON A SCALE OF 10 (HIGH) TO 0 (LOW), PLEASE INDICATE HOW EFFECTIVE YOU FEEL EACH WOULD BE:

SCALE

HIGH EFFECTIVENESS					MEDIUM		LOW EFFECTIVENESS			
10	9	8	7	6	5	4	3	2	1	0

ALLOWING RESEARCHERS TO CONSULT WITH PRIVATE FIRMS ON THEIR OWN TIME ....( )

PARTICIPATE IN A JOINT RESEARCH CONSORTIUM INVOLVING THE UNIVERSITIES, FEDERAL LABS, AND INDUSTRY ....( )

EDUCATE ALL LAB FUNCTIONS OF IMPORTANCE AND PURPOSE OF TECHNOLOGY TRANSFER AND ASSOCIATED LEGISLATION ....( )

EDUCATE ALL LAB FUNCTIONS OF IMPORTANCE AND PURPOSE OF THE OFFICE OF RESEARCH AND TECHNOLOGY APPLICATIONS ....( )

STRENGTHEN AND MAKE VISIBLE LAB DIRECTOR AND MANAGEMENT SUPPORT ....( )

INCREASE OFFICE OF RESEARCH AND TECHNOLOGY APPLICATIONS FUNDING. ....( )

INCREASE RESEARCHER FUNDING ....( )

MONETARY INCENTIVES FOR INVENTIONS ....( )

INCREASE THE NUMBER OF PERSONNEL IN THE OFFICE OF RESEARCH AND TECHNOLOGY APPLICATIONS (ORTA) ....( )

ESTABLISH AGENCY/DEPARTMENT TECHNOLOGY TRANSFER POLICY IF POLICY DOES NOT ALREADY EXIST ....( )

ESTABLISH LAB TECHNOLOGY TRANSFER POLICY IF ONE DOES NOT EXIST ....( )

INCREASE ORTA INTERACTION WITH LAB DIRECTOR ....( )

INCREASE ORTA INTERACTION WITH AGENCY DIRECTOR ....( )

USE COMPUTERIZED MAILING LIST TO NOTIFY POTENTIAL RECIPIENTS OF NEW RESEARCH, ETC. ....( )

REQUIRE REPORTING OF NEW TECHNOLOGIES TO ORTA AND LAB DIRECTOR ....( )

PROMOTE FOLLOW-UP SUPPORT OF INFORMATION REQUESTS FROM INDUSTRY ....( )

6a. PLEASE LIST YOUR SUGGESTIONS FOR FACILITATING TECHNOLOGY TRANSFER FROM YOUR LAB TO THE DOMESTIC SECTOR:

____

____

____

7. WOULD YOUR LABORATORY BENEFIT FROM CLOSER TIES WITH THE LOCAL UNIVERSITY SYSTEM RESEARCHERS?

_____ YES _____ NO

7a. WITH WHAT DEPARTMENTS OF THE UNIVERSITY WOULD YOU WORK CLOSEST? (PLEASE CHECK ALL APPLICABLE RESPONSES)

_____ MECHANICAL ENGINEERING

_____ ELECTRICAL ENGINEERING

_____ CHEMICAL ENGINEERING

_____ CIVIL ENGINEERING

_____ COMPUTER ENGINEERING

_____ COMPUTER SCIENCE

_____ BIOMEDICAL SCIENCE

_____ CHEMISTRY

_____ PHYSICS

_____ OTHER (please explain) ____________________________

____

8. DO YOU FEEL A JOINT RESEARCH CONSORTIUM INVOLVING THE UNIVERSITIES, FEDERAL LABS, AND INDUSTRY WOULD FACILITATE TECHNOLOGY TRANSFER?

_____ YES _____ NO

WHY? ____

____

____

9. DO YOU FEEL THAT A COMPANY TECHNOLOGY TRANSFER OFFICER ACTING AS A LIAISON BETWEEN THE COMPANY'S TECHNOLOGICAL NEEDS AND THE AVAILABLE TECHNOLOGY AT YOUR LABORATORY WOULD AID THE TECHNOLOGY TRANSFER PROCESS?

_____ YES _____ NO

WHY? ____

____

____

PART III
THE FEDERAL TECHNOLOGY TRANSFER ACT OF 1986

10. THE FOLLOWING ARE PROVISIONS OF PUBLIC LAW 99-502 (FEDERAL TECHNOLOGY TRANSFER ACT OF 1986). ON A SCALE OF 10 (HIGH) TO 0 (LOW), HOW WOULD YOU RATE THE VALUE OF EACH AS:

(A) AN INCENTIVE TO LAB PROJECT SCIENTISTS/ENGINEERS IN FACILITATING TECHNOLOGY TRANSFER AND,

(B) AN INCENTIVE TO THE LAB MANAGEMENT IN FACILITATING TECHNOLOGY TRANSFER

SCALE

HIGH					MEDIUM					LOW
10	9	8	7	6	5	4	3	2	1	0

	INCENTIVE TO: RESEARCHER (A)	LAB MGT (B)
TO ENTER INTO COOPERATIVE R&D ARRANGEMENTS WITH OTHER FEDERAL AGENCIES, UNITS OF STATE OR LOCAL GOVERNMENT, INDUSTRIAL ORGANIZATIONS, PUBLIC AND PRIVATE FOUNDATIONS, NON-PROFIT ORGANIZATIONS, OR OTHER PERSONS	( )	( )
TO NEGOTIATE LICENSING AGREEMENTS FOR GOVERNMENT OWNED INVENTIONS MADE AT THE LAB AND OTHER INVENTIONS OF FEDERAL EMPLOYEES THAT MAY BE VOLUNTARILY ASSIGNED TO THE GOVERNMENT	( )	( )
TO ACCEPT FUNDS, SERVICES, AND PROPERTY FROM COLLABORATING PARTIES AND PROVIDE THE SAME TO COLLABORATING PARTIES	( )	( )

TO GRANT PATENT LICENSES IN ANY INVENTION MADE BY A FEDERAL EMPLOYEE UNDER A COOPERATIVE R&D AGREEMENT

.... ( ) ( )

BEGINNING IN FY 1988, AT LEAST 15% OF THE ROYALTIES OR OTHER INCOME RECEIVED EACH YEAR BY THE AGENCY ON ACCOUNT OF ANY INVENTION SHALL BE PAID TO THE INVENTOR

.... ( ) ( )

THE BALANCE OF ANY ROYALTIES EARNED AFTER PAYING THE INVENTOR'S PORTIONS SHALL BE TRANSFERRED TO THE AGENCY'S GOVERNMENT-OPERATED LABORATORIES WITH A SUBSTANTIAL PERCENTAGE BEING RETURNED TO THE LABORATORIES WHICH PRODUCED THE ROYALTIES OF INCOME

.... ( ) ( )

11. PLEASE PROVIDE ADVICE ON WHAT YOU FEEL NEEDS TO BE DONE TO MAKE TECHNOLOGY TRANSFER FROM YOUR LAB TO THE COMMERCIAL SECTOR A SUCCESS:

____

____

____

____

Appendix C: Detailed Results for Question 5

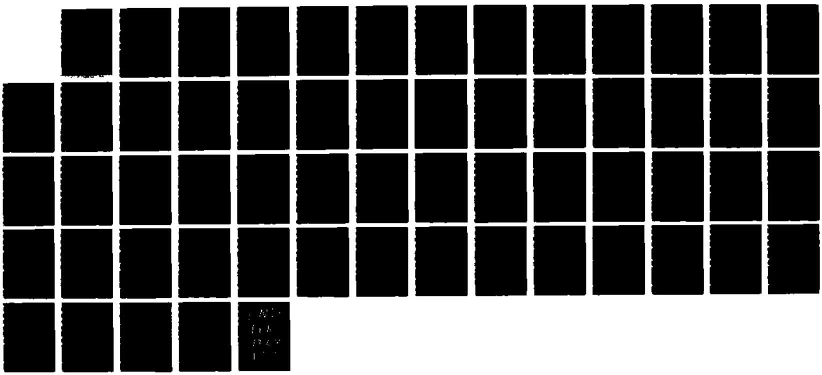
This appendix presents the descriptive statistics and analysis of data collected by the survey questionnaires for Question 5. This question listed conditions that the literature review revealed to be potential barriers to technology transfer and asked the respondents to indicate which they thought were major barriers in the transfer of technology from their laboratory to the commercial sector. The hypothesis test for nominal data mentioned in Chapter III (a test of population proportions) was applied to these data. The response distributions and percentages and results of the hypothesis tests are shown below.

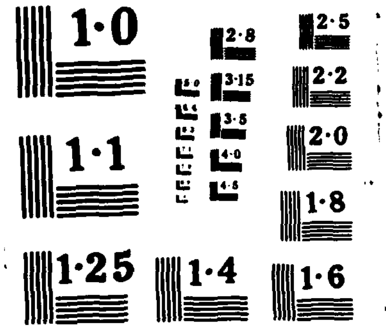
A "0" indicated the respondent thought the condition was not a barrier and a "1" indicated that the respondent thought that the condition was a barrier to technology transfer. The findings are presented beginning on the next page.

AD-A187 017 A STUDY OF FEDERAL TECHNOLOGY TRANSFER TO THE COMMERCIAL SECTOR(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF SYSTEMS AND LOGISTICS M J OLSEN SEP 87 AFIT/GLM/LSP/87S-52

2/2

UNCLASSIFIED F/G 5/2 NL




1.0
2.8
2.5
3.15
2.2
3.5
1.1
4.0
2.0
4.5
1.8
1.25
1.4
1.6

Condition 1: Lab mission statement unclear

Distributions and Percentages

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
0	71	89.8	69	85.2	72	84.7	68	90.7
1	8	10.1	12	14.8	13	15.3	7	9.3

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
0	79	86.8	61	88.4	140	87.5
1	12	13.2	8	11.6	20	12.5

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-0.89	A
Grad/Under	1.96	0.29	A
0-20/20-40	1.96	1.14	A

This research indicates that 87.5% of the respondents felt that the lab mission statement was not a barrier to technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding the lab mission statement as a barrier to technology transfer.

Condition 2: Lab management policies unclear

Distributions and Percentages

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
0	51	64.6	57	70.4	60	70.6	48	64
1	28	35.4	24	29.6	25	29.4	27	36

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
0	63	69.2	45	65.2	108	67.5
1	28	30.8	24	34.8	52	32.5

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	0.78	A
Grad/Under	1.96	-0.53	A
0-20/20-40	1.96	-0.88	A

This research indicates that 67.5% of the respondents felt that the lab management policies were not a barrier to technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding lab policies as a barrier to technology transfer.

Condition 3: Lack of positive incentives to employees

Distributions and Percentages

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
0	47	59.5	48	59.3	47	55.3	48	64
1	32	40.5	33	40.7	38	44.7	27	36

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
0	63	69.2	56	81.1	95	59.4
1	28	30.8	13	18.8	65	40.6

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-0.03	A
Grad/Under	1.96	1.69	A
0-20/20-40	1.96	1.12	A

This research indicates that 59.4% of the respondents felt that the a lack of positive incentives to employees was not a barrier to technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding lab policies as a barrier to technology transfer.

Condition 4: Classified nature of research

Distributions and Percentages

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
0	48	60.8	40	49.4	49	57.6	39	52
1	31	39.2	41	50.6	36	42.4	36	48

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
0	51	56	37	53.6	88	55
1	40	44	32	46.4	72	45

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-1.44	A
Grad/Under	1.96	-0.03	A
0-20/20-40	1.96	-0.71	A

This research indicates that 55% of the respondents felt that the classified nature of their research was not a barrier to technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding classified research as a barrier to technology transfer.

Condition 5: Lack of adequate channels of communication with industry

Distributions and Percentages

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
0	59	74.7	60	74.1	65	76.5	54	72
1	20	25.3	21	25.9	20	23.5	21	28

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
0	63	69.2	56	81.1	119	74.3
1	28	30.8	13	18.8	41	25.6

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-0.08	A
Grad/Under	1.96	1.69	A
0-20/20-40	1.96	-0.64	A

This research indicates that 74.3% of the respondents felt that the lack of communication channels with industry was not a barrier to technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding lab policies as a barrier to technology transfer.

Condition 6: Lack of interest on the part of American industry

Distributions and Percentages

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
0	69	87.3	75	92.6	75	88.2	69	92
1	10	12.7	6	7.4	10	11.8	6	8

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
0	75	82.4	55	79.7	144	90
1	16	17.6	14	20.3	16	10

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	0.07	A
Grad/Under	1.96	-0.43	A
0-20/20-40	1.96	0.79	A

This research indicates that 90% of the respondents felt that American industry's lack of interest in technology transfer was not a barrier to technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding commercial sector interest as a barrier to technology transfer.

Condition 7: Lack of awareness on the part of American industry

Distributions and Percentages

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
0	61	77.2	62	76.5	68	80	55	77.3
1	18	22.8	19	23.4	17	20	20	26.7

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
0	68	74.7	55	79.7	123	76.9
1	23	25.3	14	20.3	37	23.1

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	- 0.18	A
Grad/Under	1.96	0.73	A
0-20/20-40	1.96	-1.00	A

This research indicates that 76.9% of the respondents felt that American industry's lack of awareness concerning technology transfer was not a barrier to technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding industry awareness as a barrier to technology transfer.

Condition 8: Too much red tape for lab personnel

Distributions and Percentages

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
0	53	67.1	52	64.2	57	67.1	48	64
1	26	32.9	29	35.8	28	32.9	27	36

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
0	58	63.7	47	68.1	105	65.6
1	33	36.3	22	31.9	55	34.4

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	- 0.50	A
Grad/Under	1.96	0.57	A
0-20/20-40	1.96	-0.40	A

This research indicates that 65.6% of the respondents felt that too much "red tape" for the lab personnel was not a barrier to technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding lab "red tape" as a barrier to technology transfer.

Condition 9: Too much red tape for companies that want technology

Distributions and Percentages

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
0	68	86.1	72	88.9	71	83.5	69	92
1	11	13.9	9	11.1	14	16.5	6	8

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
0	79	86.8	61	88.4	140	87.5
1	12	13.2	8	11.6	20	12.5

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	0.48	A
Grad/Under	1.96	0.30	A
0-20/20-40	1.96	1.62	A

This research indicates that 87.5% of the respondents felt that too much "red tape" for the commercial sector was not a barrier to technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding lab policies as a barrier to technology transfer.

Condition 10: Project scientists/engineers lack awareness of the role of technology transfer

Distributions and Percentages

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
0	38	48.1	39	48.1	43	50.6	34	45.3
1	41	51.9	42	51.9	42	49.4	41	54.7

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
0	44	48.4	33	47.8	77	48.1
1	47	51.6	36	52.2	83	51.9

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-0.16	A
Grad/Under	1.96	-0.06	A
0-20/20-40	1.96	-0.66	A

This research indicates that 51.9% of the respondents felt that project scientists/engineers lacking awareness of the role of technology transfer was a barrier to technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding lab policies as a barrier to technology transfer.

Condition 11: Lab management lacks awareness of the value of technology transfer

Distributions and Percentages

	Position				Yrs Experience			
	S&E		Mgt		0-20		21-40	
	N	%	N	%	N	%	N	%
0	62	78.5	68	84	72	84.7	58	77.3
1	17	21.5	13	16	13	15.3	17	22.7

	Degree				Total	
	Grad		Under			
	N	%	N	%	N	%
0	75	82.4	55	79.7	130	81.3
1	16	17.6	14	20.3	30	18.8

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	0.82	A
Grad/Under	1.96	-0.43	A
0-20/20-40	1.96	-1.19	A

This research indicates that 81% of the respondents felt that lab management's lacking awareness of the value of technology transfer was not a barrier to technology transfer. The hypothesis tests suggest that none of the groups compared above differed significantly in their perceptions regarding lab management awareness as a barrier to technology transfer.

Condition 12: "Other"

The respondents were given the opportunity to suggest other barriers. They are summarized by category below.

- excessive paperwork, budget exercises, reporting requirements
- lack of manpower
- lack of vision/risk taking on industry's part

Appendix D: Detailed Results for Question 6

This appendix presents the descriptive statistics and analysis of data collected by the survey questionnaires. This question listed suggestions for facilitating technology transfer and asked the respondents to indicate how effective they felt each would be on a scale of "0" to "3" (low), "4" to "6" (medium), and "7" to "10" (high). The hypothesis test for ordinal data mentioned in Chapter III (the Wilcoxon Rank Sum Test) was applied to these data. The total response distributions, average scores, percentage of respondents indicating "low effectiveness", and results of the hypothesis tests are shown below.

Suggestion 1. Allow researchers to consult with private firms on their own time

Total Responses	
Scale	N
0	13
1	6
2	12
3	15
4	10
5	18
6	9
7	19
8	21
9	11
10	26

Category	Average Scores
Total	5.74
S&E	6.35
Mgt	5.15
0-20	6.04
21-40	5.41
Grad	5.90
Under	5.54

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	2.36	R
Grad/Under	1.96	0.67	A
0-20/20-40	1.96	1.14	A

Percentage of respondents
indicating "low effectiveness": 31

This research indicates that the mean effectiveness score for allowing researchers to consult with private firms on their own time was 5.74. This is at the high end of the "medium effectiveness" range. The hypothesis tests suggest that scientists/engineers and managers differed significantly in their perceptions regarding researchers consulting with private firms on their own time. The mean S&E score was over a point higher than the mean management score.

Suggestion 2. Participate in a joint research consortium involving universities, federal labs, and industry

Total Responses	
Scale	N
0	2
1	4
2	4
3	1
4	8
5	13
6	12
7	21
8	34
9	28
10	33

Category	Average Scores
Total	7.41
S&E	7.65
Mgt	7.17
0-20	7.56
21-40	7.23
Grad	7.53
Under	7.25

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	1.70	A
Grad/Under	1.96	0.91	A
0-20/20-40	1.96	0.89	A

Percentage of respondents
indicating "low effectiveness": 6.8

This research indicates that the mean effectiveness score for participating in a joint research consortium was 7.41. This is at the low end of the "high effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their perceptions regarding participation in a joint research consortium.

Suggestion 3. Educate all lab functions of the importance and purpose of technology transfer and associated legislation

Total Responses

Scale	N
0	3
1	10
2	11
3	14
4	13
5	28
6	16
7	20
8	22
9	8
10	15

Category	Average Scores
Total	5.63
S&E	5.90
Mgt	5.36
0-20	5.88
21-40	5.33
Grad	5.12
Under	6.29

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	1.28	A
Grad/Under	1.96	-2.83	R
0-20/20-40	1.96	1.28	A

Percentage of respondents indicating "low effectiveness": 38

This research indicates that the mean effectiveness score for educating all lab functions on the importance and purpose of technology transfer and associated legislation was 5.63. This is at the high end of the "medium effectiveness" range. The hypothesis tests suggest that respondents with a graduate or higher degree and respondents with an undergraduate degree differed significantly in their perceptions regarding educating all lab functions on technology transfer. The mean undergraduate score was over a point higher than the mean graduate score.

Suggestion 4. Educate all lab functions of the importance and purpose of the Office of Research and Technology Applications

Total Responses	
Scale	N
0	5
1	13
2	11
3	16
4	13
5	30
6	13
7	20
8	20
9	6
10	13

Category	Average Scores
Total	5.33
S&E	5.66
Mgt	5.00
0-20	5.69
21-40	4.91
Grad	4.92
Under	5.86

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	1.24	A
Grad/Under	1.96	-2.58	R
0-20/20-40	1.96	1.61	A

Percentage of respondents
indicating "low effectiveness": 28.1

This research indicates that the mean effectiveness score for educating lab personnel concerning the purpose and importance of the ORTA was 5.33. This is essentially in the center of the "medium effectiveness" range. The hypothesis tests suggest that graduates and undergraduates differed significantly in their perceptions regarding being educated on the importance and purpose of the ORTA. The mean undergraduate score was almost a point higher than the mean management score.

Suggestion 5. Strengthen and make visible lab director and management support

Total Responses

Scale	N
0	4
1	5
2	10
3	14
4	9
5	31
6	12
7	27
8	26
9	7
10	15

Category	Average Scores
Total	5.88
S&E	6.13
Mgt	5.63
0-20	6.02
21-40	5.70
Grad	5.85
Under	5.91

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	1.42	A
Grad/Under	1.96	-0.08	A
0-20/20-40	1.96	0.78	A

Percentage of respondents indicating "low effectiveness": 20.6

This research indicates that the mean effectiveness score for strengthening and making visible lab director and management support was 5.88. This was at the high end of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their perceptions regarding the increase of lab director and management support.

Suggestion 6. Increase Office of Research and Technology Applications funding

Scale	N
0	18
1	11
2	19
3	16
4	14
5	26
6	17
7	13
8	13
9	6
10	7

Total Responses

Category	Average Scores
Total	4.54
S&E	4.57
Mgt	4.52
0-20	4.66
21-40	4.41
Grad	4.06
Under	5.15

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-1.44	A
Grad/Under	1.96	-4.20	R
0-20/20-40	1.96	-1.04	A

Percentage of respondents
indicating "low effectiveness": 40

This research indicates that the mean effectiveness score for increasing ORTA funding was 4.54. This was at the low end of the "medium effectiveness" range. The hypothesis tests suggest that graduates and undergraduates differed significantly in their perceptions regarding ORTA funding.

The mean undergraduate score was over a point higher than the mean graduate score.

Suggestion 7. Increase researcher funding

Total Responses	
Scale	N
0	10
1	4
2	10
3	7
4	10
5	28
6	17
7	18
8	21
9	13
10	22

Category	Average Scores
Total	6.06
S&E	6.17
Mgt	5.96
0-20	6.11
21-40	6.01
Grad	5.60
Under	6.68

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-0.23	A
Grad/Under	1.96	-2.93	R
0-20/20-40	1.96	-0.70	A

Percentage of respondents
indicating "low effectiveness": 19.4

This research indicates that the mean effectiveness score for increasing researcher funding was 6.06. This is at the high end of the "medium effectiveness" range. The hypothesis tests suggest that graduates and undergraduates differed significantly in their perceptions regarding increasing researcher funding. The mean undergraduate score was over a point higher than the mean graduate score.

Suggestion 8. Monetary incentives for inventions

Total Responses	
Scale	N
0	8
1	2
2	6
3	6
4	12
5	18
6	10
7	23
8	30
9	12
10	33

Category	Average Scores
Total	6.74
S&E	7.13
Mgt	7.37
0-20	7.08
21-40	6.36
Grad	6.44
Under	7.14

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	1.98	R
Grad/Under	1.96	-0.61	A
0-20/20-40	1.96	1.61	A

Percentage of respondents
indicating "low effectiveness": 13.8

This research indicates that the mean effectiveness score for providing monetary incentives for inventions was

6.74. This was at the high end of the "medium effectiveness" range. The hypothesis tests suggest that scientists/engineers and managers differed significantly in their perceptions regarding the provision of monetary incentives. The mean management score was approximately one quarter of point higher than the mean S&E score.

Suggestion 9. Increase the number of personnel in the Office of Research and Technology Applications (ORTA)

Total Responses	
Scale	N
0	27
1	11
2	17
3	24
4	13
5	26
6	12
7	17
8	7
9	4
10	2

Category	Average Scores
Total	3.81
S&E	4.31
Mgt	3.33
0-20	4.14
21-40	3.44
Grad	3.76
Under	3.87

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	1.28	A
Grad/Under	1.96	-1.40	A
0-20/20-40	1.96	0.64	A

Percentage of respondents
indicating "low effectiveness": 49.4

This research indicates that the mean effectiveness score for increasing the number of personnel in the ORTA was 3.81. This was at the high end of the "low effectiveness" range. The hypothesis tests suggest that the above groups did not differ significantly in their perceptions regarding the increase of personnel in the ORTA.

Suggestion 10. Establish agency/department technology transfer policy if policy does not already exist

Total Responses	
Scale	N
0	13
1	11
2	8
3	10
4	15
5	34
6	17
7	13
8	14
9	8
10	17

Category	Average Scores
Total	5.28
S&E	5.81
Mgt	4.78
0-20	5.58
21-40	4.95
Grad	4.98
Under	5.67

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	1.17	A
Grad/Under	1.96	-2.21	R
0-20/20-40	1.96	0.45	A

Percentage of respondents
indicating "low effectiveness": 26.3

This research indicates that the mean effectiveness score for establishing agency/department technology transfer policy if a policy does not already exist was 5.28. This is essentially at the center of the "medium effectiveness" range. The hypothesis tests suggest that graduates and undergraduates differed significantly in their perceptions regarding the establishment of agency technology transfer policy. The mean undergraduate score was approximately seven tenths of a point higher than the mean graduate score.

Suggestion 11. Establish lab technology transfer policy if one does not exist

Total Responses	
Scale	N
0	8
1	7
2	12
3	10
4	9
5	35
6	15
7	14
8	16
9	13
10	21

Category	Average Scores
Total	5.75
S&E	6.17
Mgt	5.36
0-20	5.99
21-40	5.49
Grad	5.56
Under	6.01

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	1.36	A
Grad/Under	1.96	-1.31	A
0-20/20-40	1.96	0.57	A

Percentage of respondents indicating "low effectiveness": 23.1

This research indicates that the mean effectiveness score for establishing a laboratory technology transfer policy if a policy does not already exist is 5.75. This is at the high end of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their perceptions regarding the establishment of laboratory technology transfer policy.

Suggestion 12. Increase ORTA interaction with lab director

Total Responses	
Scale	N
0	21
1	12
2	14
3	17
4	10
5	38
6	14
7	15
8	10
9	3
10	6

Category	Average Scores
Total	4.37
S&E	4.83
Mgt	3.92
0-20	4.60
21-40	4.11
Grad	4.25
Under	4.51

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	0.48	A
Grad/Under	1.96	-2.51	R
0-20/20-40	1.96	-0.82	A

Percentage of respondents indicating "low effectiveness": 40.0

This research indicates that the mean effectiveness score for increasing ORTA interaction with the lab director was 4.37. This is at the low end of the "medium effectiveness" range. The hypothesis tests suggest that graduates and undergraduates differed significantly in their perceptions regarding the interaction of the ORTA and the lab director. The mean undergraduate score was approximately one half of a point higher than the mean graduate score.

Suggestion 13. Increase ORTA interaction with agency director

Total Responses

Scale	N
0	23
1	13
2	17
3	22
4	7
5	34
6	13
7	17
8	6
9	2
10	6

Category	Average Scores
Total	4.09
S&E	4.58
Mgt	3.62
0-20	4.22
21-40	3.95
Grad	3.85
Under	4.40

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	0.53	A
Grad/Under	1.96	-3.09	R
0-20/20-40	1.96	-1.22	A

Percentage of respondents
indicating "low effectiveness": 46.9

This research indicates that the mean effectiveness score for establishing agency/department technology transfer policy if a policy does not already exist was 4.09. This is at the low end of the "medium effectiveness" range. The hypothesis tests suggest that graduates and undergraduates differed significantly in their perceptions regarding the interaction of the agency director and the laboratory ORTA. The mean undergraduate score was approximately one half of a point higher than the mean graduate score.

Suggestion 14. Use computerized mailing list to notify potential recipients of new research, etc.

Total Responses	
Scale	N
0	14
1	11
2	13
3	19
4	7
5	26
6	12
7	24
8	12
9	9
10	13

Category	Average Scores
Total	4.99
S&E	5.47
Mgt	4.53
0-20	5.46
21-40	4.47
Grad	4.55
Under	5.58

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	2.00	R
Grad/Under	1.96	-2.16	R
0-20/20-40	1.96	2.14	R

Percentage of respondents indicating "low effectiveness": 35.6

This research indicates that the mean effectiveness score for using computerized mailing lists to notify potential recipients of new research, etc. is 4.99. This is essentially at the center of the "medium effectiveness" range. The hypothesis tests suggest that all three of the above groups differed significantly in their perceptions regarding the computerized mailing list. The mean S&E score was almost a point higher than the management score. The mean 0-20 years experience score was also almost a point higher than the 21-40 years experience mean score. The mean undergraduate score was approximately seven tenths of a point higher than the mean graduate score.

Suggestion 15. Require reporting of new technologies to ORTA and lab director

Total Responses

Scale	N
0	18
1	16
2	14
3	9
4	14
5	26
6	16
7	19
8	15
9	5
10	8

Category	Average Scores
Total	4.63
S&E	5.16
Mgt	4.12
0-20	5.08
21-40	4.12
Grad	4.47
Under	4.84

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	1.15	A
Grad/Under	1.96	-1.66	A
0-20 '20-40	1.96	0.97	A

Percentage of respondents indicating "low effectiveness": 35.6

This research indicates that the mean effectiveness score for requiring reporting of new technologies to the ORTA and the lab director is 4.63. This is close to the center of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their perceptions regarding the requirement to report new technologies.

Suggestion 16. Promote follow-up support of information requests from industry

Total Responses

Scale	N
0	15
1	3
2	14
3	12
4	7
5	27
6	19
7	30
8	24
9	2
10	7

Category	Average Scores
Total	5.31
S&E	5.57
Mgt	5.06
0-20	5.54
21-40	5.05
Grad	5.19
Under	5.47

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	0.17	A
Grad/Under	1.96	-1.62	A
0-20/20-40	1.96	0.07	A

Percentage of respondents
indicating "low effectiveness": 27.5

This research indicates that the mean effectiveness score for promoting follow-up support of information requests from industry is 5.31. This is essentially in the center of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their perceptions regarding follow-up support of information requests from industry.

Appendix E: Detailed Results for Question 10

This question listed provisions of Public Law 99-502 (Federal Technology Transfer Act of 1986) and asked the respondents to rate the value of each on a scale of "0" to "3" (low), "4" to "6" (medium), and "7" to "10" (high) as:

(A) an incentive to scientists and engineers in facilitating technology transfer and

(B) an incentive to lab management in facilitating technology transfer.

The hypothesis test for ordinal data mentioned in Chapter III (the Wilcoxon Rank Sum Test) was applied to these data. The total response distributions, average scores, and results of the hypothesis tests are shown below.

Provision 1. To enter into cooperative R&D arrangements with other federal agencies, units of state or local government, industrial organizations, public and private foundations, non-profit organizations, or other persons.

Incentive to Scientist/Engineer

Total Responses	
Scale	N
0	8
1	8
2	8
3	19
4	11
5	14
6	17
7	18
8	32
9	10
10	15

Average Scores	
Total	5.74
S&E	5.96
Mgt	5.53
0-20	5.91
21-40	5.56
Grad	5.65
Under	5.87

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	0.92	A
Grad/Under	1.96	-0.87	A
0-20/20-40	1.96	0.61	A

Percentage of respondents
indicating "low effectiveness": 24.1

This research indicates that the mean effectiveness score for cooperative R&D arrangements as an incentive to scientists/engineers was 5.74. This was at the high end of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their perceptions regarding cooperative R&D arrangements.

Incentive to Lab Management

Total Responses	
Scale	N
0	7
1	6
2	3
3	12
4	14
5	22
6	16
7	23
8	24
9	15
10	18

Average Scores	
Total	6.11
S&E	6.19
Mgt	6.04
0-20	6.13
21-40	6.09
Grad	6.09
Under	6.14

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-0.30	A
Grad/Under	1.96	-0.59	A
0-20/20-40	1.96	-0.59	A

Percentage of respondents
indicating "low effectiveness": 17.5

This research indicates that the mean effectiveness score for cooperative R&D arrangements as an incentive to lab management was 6.11. This was at the high end of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their perceptions regarding cooperative R&D arrangements.

Provision 2. To negotiate licensing agreements for government owned inventions made at the lab and other inventions of federal employees that may be voluntarily assigned to the government.

Incentive to Scientist/Engineer

Total Responses

Scale	N
0	8
1	10
2	8
3	8
4	15
5	28
6	17
7	13
8	31
9	8
10	14

Average Scores

Total	5.64
S&E	5.65
Mgt	5.09
0-20	5.69
21-40	5.59
Grad	5.77
Under	5.48

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-0.46	A
Grad/Under	1.96	-0.05	A
0-20/20-40	1.96	-0.37	A

Percentage of respondents
indicating "low effectiveness": 21.3

This research indicates that the mean effectiveness score for licensing agreements as an incentive to scientists/engineers was 5.64. This was at the high end of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their perceptions regarding cooperative R&D arrangements.

Incentive to Lab Management

Total Responses

Scale	N
0	9
1	9
2	11
3	14
4	11
5	27
6	18
7	24
8	18
9	4
10	15

Average Scores

Total	5.36
S&E	5.65
Mgt	5.09
0-20	5.40
21-40	5.32
Grad	5.11
Under	5.70

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-0.72	A
Grad/Under	1.96	-1.80	A
0-20/20-40	1.96	-0.32	A

Percentage of respondents indicating "low effectiveness": 26.9

This research indicates that the mean effectiveness score for licensing agreements as an incentive to lab management was 5.64. This was at the high end of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their perceptions regarding cooperative R&D arrangements.

Provision 3. To accept funds, services, and property from collaborating parties and provide the same to collaborating parties.

Incentive to Scientist/Engineer

Total Responses

Scale	N
0	14
1	6
2	8
3	8
4	13
5	22
6	19
7	16
8	21
9	15
10	18

Average Scores

Total	5.80
S&E	5.99
Mgt	5.62
0-20	6.10
21-40	5.47
Grad	5.78
Under	5.84

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	0.29	A
Grad/Under	1.96	-0.89	A
0-20/20-40	1.96	0.33	A

Percentage of respondents
indicating "low effectiveness": 22.5

This research indicates that the mean effectiveness score for accepting funds, services, and property from collaborating parties and providing the same to collaborating parties as an incentive to scientists/engineers was 5.80. This is at the high end of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their perceptions regarding funds, services, and property transfers.

Incentive to Lab Management

Total Responses	
Scale	N
0	11
1	9
2	10
3	7
4	11
5	21
6	17
7	21
8	24
9	10
10	19

Average Scores	
Total	5.82
S&E	5.87
Mgt	5.76
0-20	5.92
21-40	5.72
Grad	5.66
Under	6.04

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-0.32	A
Grad/Under	1.96	-1.49	A
0-20/20-40	1.96	-0.75	A

Percentage of respondents indicating "low effectiveness": 21.1

This research indicates that the mean effectiveness score for accepting funds, services, and property from collaborating parties and providing the same to collaborating parties as an incentive to lab management is 5.82. This is at the high end of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their perceptions regarding funds, services, and property transfers.

Provision 4. To grant patent licenses in any invention made by a federal employee under a cooperative R&D agreement.

Incentive to Scientist/Engineer

Total Responses

Scale	N
0	6
1	7
2	4
3	9
4	5
5	17
6	14
7	16
8	33
9	20
10	29

Average Scores

Total	6.73
S&E	7.30
Mgt	6.19
0-20	7.20
21-40	6.20
Grad	6.74
Under	6.72

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	2.33	R
Grad/Under	1.96	-0.18	A
0-20/20-40	1.96	2.15	R

Percentage of respondents
indicating "low effectiveness": 16.3

This research indicates that the mean effectiveness score for granting patent licenses for inventions made by a federal employee under a cooperative R&D agreement as an incentive to scientists/engineers was 6.73. This is at the low end of the "high effectiveness" range. The hypothesis tests suggest that scientists/engineers and management differed significantly in their opinions regarding patent licenses as did those respondents with 0-20 years of experience and those with 21-40 years of experience. The scientist/engineer score is almost one half point greater than the management score. The 0-20 years experience mean score is one point higher than the 21-40 years score.

Incentive to Lab Management

Total Responses

Scale	N
0	15
1	8
2	13
3	14
4	11
5	35
6	16
7	15
8	16
9	1
10	16

Average Scores

Total	4.96
S&E	5.18
Mgt	4.74
0-20	5.25
21-40	4.63
Grad	4.79
Under	5.17

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	0.16	A
Grad/Under	1.96	-1.94	A
0-20/20-40	1.96	0.49	A

Percentage of respondents
indicating "low effectiveness": 31.3

This research indicates that the mean effectiveness score for granting patent licenses for inventions made by a federal employee under a cooperative R&D agreement as an incentive to lab management is 4.96. This is at the center of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their opinions regarding patent licenses.

Provision 5. Beginning in FY 1988, at least 15% of the royalties or other income received each year by the agency on account of any invention shall be paid to the inventor.

Incentive to Scientist/Engineer

Total Responses

Scale	N
0	3
1	2
2	1
3	3
4	1
5	8
6	4
7	16
8	29
9	21
10	72

Average Scores

Total	8.34
S&E	8.57
Mgt	8.11
0-20	8.41
21-40	8.25
Grad	8.13
Under	8.61

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	0.38	A
Grad/Under	1.96	-1.27	A
0-20/20-40	1.96	-0.32	A

Percentage of respondents
indicating "low effectiveness": 5.6

This research indicates that the mean effectiveness score for paying inventors 15% royalties for their inventions as an incentive to scientists/engineers is 8.34. This is in the center of the "high effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their opinions regarding patent licenses.

Incentive to Lab Management

Total Responses	
Scale	N
0	17
1	8
2	13
3	14
4	11
5	31
6	21
7	14
8	10
9	5
10	16

Average Scores	
Total	4.90
S&E	4.99
Mgt	4.81
0-20	5.08
21-40	4.69
Grad	4.74
Under	5.12

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-0.30	A
Grad/Under	1.96	-1.51	A
0-20/20-40	1.96	0.15	A

Percentage of respondents
indicating "low effectiveness": 32.5

This research indicates that the mean effectiveness score for paying inventors 15% royalties for their inventions as an incentive to lab management is 4.90. This is in the center of the "medium effectiveness" range. The hypothesis tests suggest that none of the above groups differed significantly in their opinions regarding patent licenses.

Provision 6. The balance of any royalties earned after paying the inventor's portions shall be transferred to the agency's government-operated labs with a substantial percentage being returned to the labs which produced the royalties of income.

Incentive to Scientist/Engineer

Total Responses

Scale	N
0	10
1	10
2	9
3	4
4	11
5	30
6	14
7	17
8	17
9	6
10	32

Average Scores

Total	5.92
S&E	6.54
Mgt	5.31
0-20	6.11
21-40	5.71
Grad	5.84
Under	6.03

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	2.25	R
Grad/Under	1.96	-0.53	A
0-20/20-40	1.96	0.56	A

Percentage of respondents
indicating "low effectiveness": 20.6

This research indicates that the mean effectiveness score for transferring the balance of inventor royalties (after paying inventors 15%)to the laboratory as an incentive to scientists/engineers is 5.92. This is in the high end of the "medium effectiveness" range. The hypothesis tests suggest that scientists/engineers and management differed significantly in their opinions regarding the return of patent income to the lab. The S&E score was six tenths of a point higher than the mean management score.

Incentive to Lab Management

Total Responses	
Scale	N
0	5
1	5
2	2
3	1
4	7
5	18
6	6
7	11
8	30
9	23
10	52

	Average Scores
Total	7.56
S&E	7.72
Mgt	7.41
0-20	7.66
21-40	7.45
Grad	7.16
Under	8.09

Hypothesis Test Results

Category	Critical Statistic	Test Statistic	Accept/ Reject
S&E/Mgt	1.96	-0.21	A
Grad/Under	1.96	-2.34	R
0-20/20-40	1.96	-0.55	A

Percentage of respondents
indicating "low effectiveness": 8.1

This research indicates that the mean effectiveness score for transferring the balance of inventor royalties (after paying inventors 15%) to the laboratory as an incentive to lab management is 7.56. This is close to the center of the "high effectiveness" range. The hypothesis tests suggest that graduates and undergraduates differed significantly in their opinions regarding the return of patent income to the lab. The undergraduate score was almost a point higher than the mean graduate score.

Bibliography

1. Barry, John M. "At Last - A Reagan Technology Policy?," Dun's Business Month, 127: 58-59 (April 1986).

2. Benson, P. George and McClave, James T. Statistics for Business and Economics (Third Edition). San Francisco: Dellen Publishing Company, 1985.

3. Blanchard, Paul A. and McDonald, Frank B. "Reviving the Spirit of Enterprise: Role of the Federal Labs," Physics Today, 39: 42-50 (January 1986).

4. Department of the Air Force. A Guide for the Development of the Attitude and Opinion Survey. Washington: HQ USAF/ACM, October 1974.

5. Doctors, Samuel I. The Role of Federal Agencies in Technology Transfer. Cambridge: The M.I.T. Press, 1969.

6. Federal Laboratory-Industry Interaction Working Group of the Federal Laboratory Consortium. Interagency Study of Federal Laboratory Technology Transfer Organization and Operation. DOE/METC-85/6019 (DE85003397). Morgantown WV: U.S. Dept. of Energy, May 1985.

7. "Government Focus on Data Transfer to Industry Urged," Aviation Week & Space Technology, 121: 131-133 (23 July 1984).

8. Heaton, Jr., George R. and Holloman, J. Herbert. "Technological Diffusion and National Policy," Research Management, 27:5-7 (January/February 1984).

9. Hinkle, Dennis E. and others. Applied Statistics for the Behavioral Sciences. Chicago: Rand McNally College Publishing Company, 1979.

10. Hough, Granville W. Technology Diffusion. Mt. Airy MD: Lomond Systems, Inc, 1975.

11. Korenko, M.K. "A Technology Transfer Experience," CHEMTECH, 16: 392-395 (July 1986).

12. Mendenhall, William and James E. Reinmuth. Statistics for Management and Economics (Third Edition). North Scituate MA: Duxbury Press, 1978.

13. National Science Foundation. National Patterns of Science and Technology Resources 1986. Washington: Government Printing Office, 1986.

14. Premus, Dr. Robert P., Professor of Economics and Director, Center for Industrial Studies, Wright State University, Dayton, Ohio. "Federal Laboratories and Urban Development in Ohio: The Dayton - Wright-Patterson Air Force Base Experience." A research proposal submitted to the Ohio Board of Regents Advisory Committee on Urban University Programs. 14 February 1986.

15. Smith, Timothy K. "Bill Aims to Ease Transfer of Technology From Federal Laboratories to Businesses," The Wall Street Journal, 68:35 (1 October 1986).

16. Stark, Eugene. A Federal Laboratory Consortium news release regarding the Federal Technology Transfer Act of 1986. FLC Chairman, Los Alamos Mational Laboratory, Los Alamos NM, 29 October 1986.

17. U.S. Congress. A study prepared for the use of the Joint Economic Committee. The U.S. Climate for Entrepreneurship and Innovation. Washington: U.S. Government Printing Office, 1985.

18. U.S. Congress. The Stevenson-Wydler Technology Innovation Act of 1980. Public Law No. 96-480, 96th Congress. Washington:Government Printing Office, 21 October 1980.

19. U.S. Congress. Federal Technology Transfer Act of 1986. Public Law No. 99-953, 99th Congress. Washington: Government Printing Office, 2 October 1986.

VITA

Captain Michael J. Olsen was born on 30 December 1956 in Rome, New York. He graduated from Warner Robins High School in 1974 and attended Valdosta State College from which he received the degree of Bachelor of Business Administration in December 1979. Upon graduation he was commissioned a second lieutenant in the U.S. Air Force and served as a Production and Quality Assurance Officer with the Reconnaissance and Electronic Warfare Systems Program Office at Wright-Patterson A.F.B. He then served as Manufacturing Branch Chief with the Lockheed Georgia Company Air Force Plant Representatives Office until entering the Air Force Institute of Technology in June 1986.

Permanent Address: 110 Rockywood Way
Niceville, Florida 32578

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

AD-A187017

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION
UNCLASSIFIED

1b. RESTRICTIVE MARKINGS

2a. SECURITY CLASSIFICATION AUTHORITY

2b. DECLASSIFICATION / DOWNGRADING SCHEDULE

3. DISTRIBUTION / AVAILABILITY OF REPORT
Approved for public release; distribution unlimited

4. PERFORMING ORGANIZATION REPORT NUMBER(S)
AFIT/GLM/LSP/87S-52

5. MONITORING ORGANIZATION REPORT NUMBER(S)

6a. NAME OF PERFORMING ORGANIZATION
School of Systems and Logistics

6b. OFFICE SYMBOL *(If applicable)*
AFIT/LSY

7a. NAME OF MONITORING ORGANIZATION

6c. ADDRESS *(City, State, and ZIP Code)*
Air Force Institute of Technology
Wright-Patterson AFB OH 45433-6583

7b. ADDRESS *(City, State, and ZIP Code)*

8a. NAME OF FUNDING / SPONSORING ORGANIZATION

8b. OFFICE SYMBOL *(If applicable)*

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER

8c. ADDRESS *(City, State, and ZIP Code)*

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO	WORK UNIT ACCESSION NO.

11. TITLE *(Include Security Classification)*
A STUDY OF FEDERAL TECHNOLOGY TRANSFER TO THE COMMERCIAL SECTOR

12. PERSONAL AUTHOR(S)
Michael James Olsen, B.B.A., Capt, USAF

13a. TYPE OF REPORT
MS Thesis

13b. TIME COVERED
FROM ________ TO ______

14. DATE OF REPORT *(Year, Month, Day)*
1987 September

15. PAGE COUNT
153

16. SUPPLEMENTARY NOTATION
Prepared in cooperation with Dr. Robert Premus, Director, Center for Industrial Studies, Wright State University, Dayton, Ohio 45435

17. COSATI CODES

FIELD	GROUP	SUB-GROUP
05	02	

18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
Federal Laboratory, Technology Transfer, Private Industry

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

Thesis Chairmanship: Charles M. Farr, Major, USAF

Approved for public release: IAW AFR 190-1.
LYNN E. WOLAVER 29 Sept 87
Dean for Research and Professional Development
Air Force Institute of Technology (ATC)
Wright-Patterson AFB OH 45433

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT
☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION
UNCLASSIFIED

22a. NAME OF RESPONSIBLE INDIVIDUAL
Charles M. Farr, Major, USAF

22b. TELEPHONE *(Include Area Code)*
(513) 233-4845

22c. OFFICE SYMBOL
AFIT/LSY

DD Form 1473, JUN 86 *Previous editions are obsolete.*

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

Block 19. Abstract

The Federal Technology Transfer Act of 1986 imposed legislative requirements on federal labs to take certain actions to facilitate the transfer of federally developed technology to the commercial sector. This study examined the requirements of the 1986 Act and had the following three specific objectives: 1) to examine opportunities and barriers, as perceived by federal laboratory personnel, to the commercial application of federally developed technology to the private sector, 2) to examine the perceptions of federal laboratory personnel regarding the 1986 Act, and 3) to use the information from the first two objectives to suggest ways to ease and enhance the ever challenging process of technology transfer. A survey of 479 federal lab personnel including both managers and scientists/engineers was conducted in support of the above objectives. Overall, the results of the study support the findings of previous research. Recommendations are offered to help make technology transfer and the implementation of the 1986 Act a success.

END
FEb.
1988
DTIC