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TECHNOLOGY TRANSFER THROUGH
COOPERATIVE RESEARCH AND DEVELOPMENT

by

AUDIE EUGENE HITTLE

B.S. Electrical Engineering, University of New Mexico, 1983
M.S. Engineering Management, Western New England College, 1986



Submitted to the Alfred P. Sloan School of Management
and the School of Engineering
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE IN
THE MANAGEMENT OF TECHNOLOGY

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

June 1991

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TECHNOLOGY TRANSFER THROUGH COOPERATIVE RESEARCH AND DEVELOPMENT

by

AUDIE EUGENE HITTLE

Submitted to the Alfred P. Sloan School of Management
and the School of Engineering on May 10, 1991
in partial fulfillment of the requirements for the degree of
Master of Science in the Management of Technology

ABSTRACT

→ In 1986 the U.S. Congress passed the Federal Technology Transfer Act. This legislation created opportunities for greater utilization of the \$70 billion per year federal research and development budget. This enhanced utilization, accomplished by technology transfer from federal labs to the public and private sector, is intended to boost the economy and improve national competitiveness. However, laboratory and commercial response to this legislation has been slow and there appears to be a reluctance or inability to tap these vital technology resources. Understanding the technology transfer barriers and issues is key to improving the process and capitalizing upon this national investment.

This research was accomplished through extensive documentation reviews and interviews with representatives from federal laboratories and the commercial industrial sector. A series of hypotheses were developed based upon the background literature research and preliminary informal discussions. Analyses were performed on the data collected from the interviews to validate the hypotheses. From these analyses, recommendations were made to describe how the U.S. federal laboratories and private sector can work more cooperatively to achieve a higher level of technology transfer and utilization.

Research indicates that government-industry cooperative research and development agreements (CRDAs) are viewed positively by 90% of those interviewed. Results indicate that a major awareness campaign needs to be initiated and the government-industry CRDAs need to be clearly distinguished from the federal acquisition system to dispel the perception of government red tape. Finally, greater understanding of the perspectives and needs of potential cooperative participants must occur to improve the efficiency and effectiveness of negotiating technology transfer cooperative R&D agreements.

Thesis Supervisor: Dr. Ernst G. Frankel
Title: Professor of Engineering

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TECHNOLOGY TRANSFER THROUGH COOPERATIVE RESEARCH AND DEVELOPMENT

by

CAPT AUDIE EUGENE HITTLE , USAF

Submitted to the Alfred P. Sloan School of Management
and the School of Engineering on May 10, 1991
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Thesis Supervisor: Dr. Ernst G. Frankel
Title: Professor of Engineering

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Finally, I am truly thankful for the love, encouragement and support provided by my wife Karina, my daughter Kamah, and Rosemary my mother-in-law. Each of you has endured the year with me and helped me to continuously overcome the problems and successfully deal with the challenges of one incredible year at M.I.T.

BIOGRAPHY

AUDIE E. HITTLE

Audie E. Hittle was born and raised in the dairy farm country of north-eastern Pennsylvania. While completing high school, he enlisted in the United States Air Force and was selected for technical training in computer operations. After five years in computer operations and resource management, he was selected for an Air Force sponsored undergraduate electrical engineering degree and commissioning program. Upon graduation from the University of New Mexico and Air Force Officers Training School in 1983, Audie reported to Hanscom Air Force Base near Boston, Massachusetts for his first assignment as an officer and engineer.

Assigned to the Electronic Systems Division of Air Force Systems Command, Captain Hittle's first job was as lead project engineer and test director of a tactical air surveillance radar system. Job responsibilities encompassed a spectrum of functions from parts control through engineering documentation evaluation and system test coordination. While completing an engineering management Master's degree in 1986, Audie was promoted to program manager. As manager of a new USAF command and control software development program, he had the opportunity to champion the effort through the conceptual design phase into full scale engineering development.

After nearly five years in project engineering and program management, Audie applied and was selected for the USAF Laboratory Associate Program at M.I.T. Lincoln Laboratory. For over two years he conducted advanced research involving radar and electro-optical sensor space surveillance systems. Recently he extended his federal laboratory research activities to include management research in domestic technology transfer - that is, the transfer of U.S. federally sponsored research to the commercial sector. His participation in the M.I.T. Management of Technology Program is part of a personal initiative to enhance the transfer and utilization of advanced technologies from U.S. federal laboratories thereby improving national competitiveness and strengthening U.S. economic and national security.

Aside from his investment in family quality time activities, Audie enjoys golfing, woodworking and carpentry. Also, he is an artist and feels at ease with almost any medium. Captain Audie Hittle firmly believes that the challenges currently facing his country and the world provide ample opportunity, for him as an artist and engineer, to exercise a creative response to the most demanding organizational or technological problems.

TABLE OF CONTENTS

| | | |
|-------|--|----|
| 1. | INTRODUCTION | 10 |
| 1.1 | Objective | 10 |
| 1.2 | Organization, Methodology and Overview | 10 |
| 2. | BACKGROUND, DEFINITIONS AND STATE OF AFFAIRS | 13 |
| 2.1 | Definition of Technology Transfer | 13 |
| 2.2 | Why is technology transfer important to address now? | 14 |
| 2.3 | What is technology transfer expected to accomplish? | 19 |
| 3. | TECHNOLOGY TRANSFER LEGISLATION | 21 |
| 4. | TECHNOLOGY TRANSFER MECHANISMS & BARRIERS | 26 |
| 4.1 | Mechanisms | 26 |
| 4.2 | Barriers | 32 |
| 5. | DATA ANALYSIS PLAN | 36 |
| 5.1 | Hypothesis definition | 38 |
| 6. | RELATIVE ASPECTS OF NEGOTIATION THEORY | 42 |
| 7. | PERSPECTIVES | 46 |
| 7.1 | Commercial management perspective | 46 |
| 7.1.1 | Main thoughts | 46 |
| 7.1.2 | Feelings about cooperative R&D | 48 |
| 7.1.3 | Barriers perceived | 49 |
| 7.1.4 | Opportunity Awareness | 50 |
| 7.1.5 | Involvement | 51 |
| 7.1.6 | General comments | 51 |
| 7.2 | Laboratory management perspective | 52 |
| 7.2.1 | Main thoughts | 53 |
| 7.2.2 | Feelings about cooperative R&D | 56 |
| 7.2.3 | Barriers perceived | 57 |
| 7.2.4 | Opportunity awareness | 63 |
| 7.2.5 | Involvement | 64 |
| 7.2.6 | General comments | 65 |
| 7.3 | Laboratory research staff perspective | 68 |
| 7.3.1 | Main thoughts | 68 |
| 7.3.2 | Feelings about cooperative R&D | 71 |
| 7.3.3 | Barriers perceived | 72 |
| 7.3.4 | Opportunity awareness | 75 |
| 7.3.5 | Involvement | 76 |
| 7.3.6 | General comments | 77 |

| | | |
|--------|--|-----|
| 7.4 | Legal counsel perspective | 79 |
| 7.4.1 | Main thoughts | 80 |
| 7.4.2 | Feelings about CRDA efforts | 82 |
| 7.4.3 | Barriers perceived | 82 |
| 7.4.4 | Opportunity awareness | 83 |
| 7.4.5 | Involvement | 84 |
| 7.4.6 | General comments | 84 |
| 7.5 | Technology transfer specialists perspective | 85 |
| 7.5.1 | Main thoughts | 86 |
| 7.5.2 | Feelings about CRDAs | 90 |
| 7.5.3 | Barriers perceived | 90 |
| 7.5.4 | Opportunity awareness | 93 |
| 7.5.5 | Involvement | 93 |
| 7.5.6 | General comments | 94 |
| 7.6 | Economist's perspective | 95 |
| 7.6.1 | Main thoughts of a Nobel Laureate | 95 |
| 7.6.2 | Feelings about cooperative R&D | 96 |
| 7.6.3 | Barriers perceived | 96 |
| 7.6.4 | General comments | 97 |
| 8. | CRDA NEGOTIATION PROCESS | 98 |
| 8.1 | Initial Contact Phase | 99 |
| 8.2 | Coordination and Negotiation Phase | 104 |
| 8.3 | Review and Approval Phase | 107 |
| 8.4 | Summary of CRDA negotiation process | 109 |
| 9. | ANALYSIS | 112 |
| 9.1 | Awareness is key | 112 |
| 9.2 | Key barrier is perceived government red tape | 118 |
| 9.3 | Understanding is the key to success | 119 |
| 10. | RECOMMENDATIONS | 121 |
| 10.1 | General recommendations from the hypotheses analyses | 121 |
| | Phase I: Implement an awareness expansion effort | 122 |
| | Phase II: Eradicate the red tape perception | 124 |
| | Phase III: Prepare for negotiations | 126 |
| 10.2 | Specific recommendations for research participants | 127 |
| 10.2.1 | Sponsoring government agency | 127 |
| 10.2.2 | Commercial management | 129 |
| 10.2.3 | Laboratory management | 131 |
| 10.2.4 | Laboratory staff | 135 |
| 10.2.5 | Technology transfer specialist | 136 |
| 10.2.6 | Legal counsel | 137 |

| | |
|---|-----|
| 11. SUMMARY AND CONCLUSION | 138 |
| REFERENCES | 144 |
| Appendix A: Technology Transfer Thesis Research Lab Questionnaire . . . | 150 |
| Appendix B: Technology Transfer Thesis Research Commercial Questionnaire | 151 |
| Appendix C: Full text interview Example #1 | 152 |
| Appendix C: Full text interview Example #2 | 155 |
| Appendix C: Full text interview Example #3 | 156 |
| Appendix D: Technology Transfer Thesis Data Base | 158 |

LIST OF FIGURES

| | |
|---|-----|
| Figure 5-1: Distribution of Interview Participants | 39 |
| Figure 7.1: Commercial Management structured interview responses | 48 |
| Figure 7.2: Laboratory Management structured interview responses | 56 |
| Figure 7.3: Laboratory Staff structured interview responses | 71 |
| Figure 7.4: Legal Counsel structured interview responses | 80 |
| Figure 7.5: Technology Transfer Specialist's structured interview responses | 90 |
| Figure 9.1: Level of technology transfer opportunity and guideline awareness | 114 |

LIST OF TABLES

| | |
|---|-----|
| Table 1: Technology Transfer Legislation Chronology | 22 |
| Table 2: Summary of Interview Responses | 113 |

1. INTRODUCTION

1.1 Objective

How can technology transfer from U.S. Federal laboratories be enhanced to improve the economic and national security of the United States? The objective of this thesis is to understand the barriers, problems and issues surrounding technology transfer from U.S. federal laboratories to the private industrial sector for the purpose of commercialization and to develop a set of recommendations for enhancing the utilization of federal laboratory technology. Understanding the concerns and the perspectives of the individuals who are responsible for or could assist with these vital technology transfer activities is key to improving the overall process and capitalizing upon this national investment.

1.2 Organization, Methodology and Overview

This thesis research represents an in-depth investigation of technology transfer literature and the perspectives of the key participants involved in the technology transfer process. The literature search was designed to identify the historical and current state of technology transfer activities and to determine what the role of federal agencies have played in the process. In addition, copies and summaries of technology transfer legislation were reviewed and analyzed to ascertain and develop an appreciation of the current legal opportunities and requirements. Technology transfer mechanisms and barriers were specifically researched to provide a current status of the state-of-the-art and to assist in developing hypotheses for subsequent evaluation during the

interview and analysis phase of the research effort.

As the preliminary thesis research activities proceeded, the importance of personal interaction became clear and the negotiations process became increasingly important. Consequently, the scope of the research was refocused to include the relevant aspects of negotiations in technology transfer and the cooperative research and development process. Technology transfers through people. This is well documented in a substantial body of literature written on the subject. Since technology transfers through people and these people are involved in multiple negotiations to effect this transfer, it seemed reasonable and necessary to understand the perspectives of the various key participants in the process and to analyze how these perspectives affected the process. Therefore, a significant part of this thesis research effort was devoted to interviewing 67 individuals within three federal labs and the commercial industrial sector.

Beyond the background documentation research and the individual structured interviews, in-depth follow-up interviews were conducted with selected representatives of the federal labs and commercial sector partners to understand, document and subsequently analyze the cooperative research and development process. This process (described in detail in Chapter 8 of this thesis) represents the principal new technology transfer mechanism authorized by the U.S. Congress to stimulate interaction between federal labs and the private industrial sector - the Cooperative Research and Development Agreement (CRDA). The data collected on participant perspectives and these

cooperative research and development processes were then analyzed to identify were the critical interactions occurred and how the associated negotiations could be improved.

Finally, an overall analysis was accomplished to evaluate the hypotheses and to summarize the implications all of the many technical, organizational, political and societal forces affecting technology transfer. From this analysis both general recommendations and specific recommendations for the technology transfer participants were drawn.

2. BACKGROUND, DEFINITIONS AND STATE OF AFFAIRS

How can technology transfer from U.S. Federal laboratories be enhanced to improve the economic and national security of the United States? Before attempting to address this question, there are three absolutely critical questions which must be answered concerning technology transfer. The questions are:

- (1) What is the definition of technology transfer in this context?
- (2) Why is it important to address this topic now?
- (3) What is the enhanced technology transfer expected to accomplish?

By answering these questions one can begin to develop an understanding of the issues and concerns associated with technology transfer and to identify the most important aspects for further research emphasis.

2.1 Definition of Technology Transfer

To establish a common understanding of the topic to be addressed, we begin with the definition of technology transfer used in this thesis. Technology transfer is "oral or written information or data; hardware; personnel, services, facilities, equipment; or other resources relating to scientific or technological developments of a U.S. Government Research, Development, Test and Engineering (RDT&E) activity, provided or disclosed by any means to another federal agency; a state or local government; an industrial organization, including cooperation, partnership, limited partnership, or industrial development organization; public or private foundation; nonprofit organization, including a university; or other person to enhance or promote technological or

industrial innovation for a commercial or public purpose" (AFR 80-27, 1990, p.1).

Within the U.S. Federal Government, the Department of Defense (DoD) and the Air Force (USAF) this type of technology transfer is specifically referred to as Domestic Technology Transfer (DT2). Therefore, for the remainder of this paper, technology transfer is intended to mean DT2.

2.2 Why is technology transfer important to address now?

Why is DT2 important to address now? There has been increasing emphasis placed on the importance of technology transfer by the U.S. President and Congress (See Chapter 3 for the chronology and brief summary of technology transfer legislation and executive actions).

Aside from this legislation, and subsequent Federal and military regulations which require enhanced technology transfer to the public and private sectors, some would argue that technology transfer is essential for the United States to remain competitive in the international market place. On April 10, 1987, President Ronald Reagan stated that "It is important not only to ensure that we maintain American preeminence in generating new knowledge and know-how in advanced technologies, but also that we encourage the swiftest possible transfer of federally developed science and technology to the private sector. All of the provisions of (Executive Order 12591) are designed to keep the United States on the leading edge of international competition" (Presidential press release, 10 Apr 87).

In his book on the role of federal agencies in technology transfer, Samuel I. Doctors stated that "Because federal expenditures for R&D preempt so large a part of our technical resources of manpower and facilities, it is important for the health of the economy that these expenditures be as effective as possible in generating additional economic growth without detriment to the original public objective for which they were made. This suggests that if the federal government is to ensure that the maximum benefit accrues to the national economy, it should devote considerable attention to the technology transfer process itself and tailor its policies in all areas of technological activity to make this transfer as effective and as rapid as possible" (Doctors, 1969, p.viii). While Doctor's observations and statements alone are not so incredibly stunning, what is remarkable is that his words are every bit as true now more than 20 years later after they were first written and that the urgency for this national attention and focus is more important than ever.

In the discussion paper published by the National Academy Press on the topic of science and technology status, trends and issues, the expenditures referred to by Doctors are quantified. These data indicate that total Federal funding of U.S. R&D was approximately \$50 billion at the time Doctors' book was published in 1969 and represented some 60% of total U.S. expenditures. This figure dipped to around \$40 billion in the mid 1970s and then rose to \$60 billion by which represented 50% of all R&D funded in the U.S. (The Government-University-Industry Research Roundtable, 1989, p.2-15). These figures indicate the relative magnitude of the investment and suggest the

importance of the federal contribution to R&D in this country, both historically and presently.

Tom Allen, in his book on managing the flow of technology, notes that technology transfer through government laboratories is "an important force in promoting the flow of informal documentation among firms" (Allen, 1977, p.88). Allen goes on to identify the importance of accessibility as a major reason industrial organizations consulted federal sponsored research facilities (Ibid, p.127).

Now more than ever, with the passage of technology transfer legislation since 1980, the ease of access can not be overstated. When Allen's book was written, many federally sponsored research organizations may have been readily accessible, but they were not actively seeking opportunities for technology transfer. Now, federal legislation encourages all government sponsored research organizations to consider unclassified technology transfer applications as part of their primary missions and requires progressive measures be implemented. In addition, thesis interviews with key government representatives have indicated that new government (in particular USAF) policies are currently being drafted which will require the Air Force sponsored research facilities to find a "partner" for all sponsored research with potential commercial applications. This policy is expected to be phased in gradually and be in full effect by 1994.

In a recent Air Force publication, Randy Meeker, Chief of Industrial Programs Division at Headquarters Air Force Systems Command commented

on the importance of technology transfer and the tasks which lie ahead. He stated that "the United States' biggest research and development challenge is getting our technologies off the shelf and into the commercial marketplace. Marketing Air Force technology with business and encouraging its commercial application is one way to put [the technology] to work for both the Air Force and our entire economy." (Meeker, 1989, p. 5)

In addition to "getting the technology off-the-shelf," perhaps the greatest challenge and benefit will be in helping the commercial sector to work more closely with the Federal labs in earlier stages of research and development.

Much of the sentiment which reflects the importance our national leaders place on domestic technology transfer was stated by Congressman Ron Wyden when he said "The most important single resource for new technologies may be the federal laboratory system - a network of several hundred labs which spends more than sixty billion federal tax dollars per year for both basic and applied research." (Technology Access Report, p. 5, 15 Nov 89)

In recognition of the importance and contribution to the economic health and security which the Federal laboratories can provide, the President's Science Advisor, D.Allan Bromley stated, "We now need to develop a more pro-active program for identifying and 'marketing' federal technology." (D. Allan Bromley, Director of the Office of Science and Technology Policy, Washington Post, 4 Dec 89)

One aspect of the emphasis on DT2 which isn't always clarified is how, by enhancing transfer of advanced technologies to the commercial sector, the

Federal Government - and in particular the DoD - benefits. In a telephone interview conducted with the current AF Domestic Technology Transfer Manager, he indicated that "everybody knows that technology transfers through industry. In addition to commercialization, we have the commercial company becoming familiar with the [development and application of] technology. Then, when the Air Force is confident in accepting it, the technology finds its way back into Air Force systems." Ultimately this allows the Air Force to purchase the products and systems it needs essentially off-the-shelf, thereby saving money by precluding the development and production of unique "militarized" versions of the product. In addition to the more effective utilization, this type of technology transfer activity is also seen as strengthening the overall domestic industrial foundation.

A Washington Post reporter recently commented on the important link between the military-industrial and commercial sectors by observing that "Lawmakers supporting the (HDTV and Sematech) projects join a widening group in industry and academia who believe that America's military strength is closely tied to the health of its commercial industries. They argue that small amounts of federal funding for technologies with applications in both the civilian and military sectors can make a big difference in America's ability to maintain a strong defense." (Morgan, Washington Post, 1989)

Consequently, now is the time for enhanced technology transfer. Now, while the U.S. maintains an edge in world class R&D. Now, while the new legislation is fresh in the minds of national leaders and political support will be

easier to achieve. Now, when the laboratories can contribute the most to regaining the U.S. competitive advantage and enhancing the country's economic and national security.

2.3 What is technology transfer expected to accomplish?

Finally, answering the last of the three critical questions, "what is the technology transfer expected to accomplish?", sets the stage for understanding how can technology transfer from U.S. Federal laboratories be enhanced to improve the economic and national security of the United States. According to the DoD DT2 Regulation 3200.12-R-4, dated December 1988, some of the primary objectives of the DT2 include the following:

- More rapid dissemination of scientific and technical information, data, and know-how developed for the DoD to the public and private sector, consistent with U.S. national security requirements.

- Sharing of technology that fosters the advance of science or that has commercial potential and thus should be employed to best advantage for the security and socio-economic well-being of the U.S.

- Enhanced coordination between U.S. industrial, academic and Government R&D activities.

- Enhanced cooperation to stimulate innovation with emphasis in small business environments.

Although these are but a few of the primary objectives, they are the ones which most directly address the mutually beneficial aspects of technology

transfer and cooperative R&D ventures between federal laboratories and the commercial sector.

Now, with a greater understanding of what technology transfer is; why it is important now; and what it's expected to accomplish; we are better prepared to address the question of how technology transfer from U.S. Federal laboratories can be enhanced to improve the economic and national security of the United States.

To enhance or improve any process, one must first appreciate the mechanisms by which the process works and the barriers or obstacles which are impeding the desired progression. Therefore, the next two chapters of this thesis address the recent legislation which has created many new opportunities for technology transfer and some of the well documented mechanisms and barriers associated with the technology transfer process.

3. TECHNOLOGY TRANSFER LEGISLATION

In 1986 the U.S. Congress passed the Federal Technology Transfer Act. This legislation opened the doors of opportunity for this country to make a greater utilization of the \$70 billion per year federal research and development budget. This enhanced utilization is to be accomplished by transferring the technologies from U.S. federal labs to the domestic public and private sector. In particular, opportunities for greater public access and private sector commercialization of these federally funded technologies are expected to provide a much needed boost to the U.S. economy and improve national competitiveness. Since 1980 Congress has been tackling the antitrust and patent retention legislation to enhance innovation within universities and small businesses. There was also some early recognition of the need for a formal office within federal laboratories to perform technology application assessments. But, it wasn't until 1986 that the movement towards enhancing technology transfer from federal laboratories took hold. Since then, every year there has been some new executive order or piece of legislation to strengthen and broaden the opportunities available at these national technological treasures as highlighted in the Signal Journal article (Ball, 1990, pp. 85-90). Table 1 and the following paragraphs summarize this pertinent legislation.

Table 1: Technology Transfer Legislation Chronology

- (1) The Stevenson-Wydler Technology Innovation Act of 1980
- (2) The Bayh-Dole University and Small Business Patent Procedure Act of 1980
- (3) The national Cooperative Research Act of 1984
- (4) The Federal Technology Transfer Act of 1986
- (5) The National Defense Authorization Act, 1987
- (6) Executive Order 12591, "Facilitating Access to Science and Technology," April 1987
- (7) The Technology Competitiveness section of The Omnibus Trade and Competitiveness Act of 1988
- (8) The National Competitiveness Technology Transfer Act of 1989
- (9) National Defense Energy Technology Transfer Act, November 1989

Each of these documents is important and essential in the opportunities they open and the focus they help create for addressing this matter now. To help better understand the implications of each legislative act or executive order, they are summarized as follows:

(1) The Stevenson-Wydler Technology Innovation Act of 1980.

- Established and funded Offices of Research and Technology Applications (ORTAs) at federal laboratories with 200 or more scientists and engineers, the

purpose of which is to identify and provide information on technologies to private industry, universities and state and local governments for use in other research or commercialization efforts.

- Established the Center for the Utilization of Federal Technology, which is located at the National Technical Information Service.

(2) The Bayh-Dole University and Small Business Patent Procedure Act of 1980

- Allows small firms and universities to get and retain the title to inventions funded by the federal government.

(3) The national Cooperative Research Act of 1984

- Permits consortia of companies, with proper registration with the Department of Commerce, to enter into joint ventures without violating antitrust laws (i.e., precompetitive R&D). The law does not allow co-production.

(4) The Federal Technology Transfer Act of 1986

- Grants government laboratory directors authority to enter into cooperative research and development agreements (CRDAs) with for-profit corporations, to assign patent rights to firms participating in cooperative agreements and to license technologies.

- Provides for the retention of licensing royalties by government labs.
- Mandates that a minimum 15 percent of royalties on federal patents be awarded to federal inventors.

- Institutionalized and funded the Federal Laboratory Consortium (FLC) for technology transfer with a charter to transfer technology from the federal

laboratories to industry, universities and state and local governments.

(5) The National Defense Authorization Act, 1987

- Encourages the Secretary of Defense to transfer Department of Defense (DoD) developed technology to other U.S. private and public sector organizations and individuals to the extent that it is consistent with national security objectives.

- Calls for the Secretary to examine and implement methods to enable DoD personnel to promote technology transfer.

(6) Executive Order 12591, "Facilitating Access to Science and Technology," April 1987

- Calls on the Secretary of Defense, to promote the commercialization of science and technology; to identify new technologies that potentially would be useful to U.S. industries and universities; and to accelerate efforts to make these technologies more accessible to potential domestic users.

(7) The Technology Competitiveness section of The Omnibus Trade and Competitiveness Act of 1988

- Changed the National Bureau of Standards' name to the National Institute of Standards and Technology (NIST) and broadened the organization's role from developing/disseminating measurement standards and scientific data to promoting the commercialization and transfer of federally developed technology to private industry and state and local government.

- Initiated regional centers for transfer of manufacturing technology, made provisions to assist state technology extension programs and established a

clearing-house for state and local initiatives on productivity, technology and innovation.

(8) The Domenici National Competitiveness Technology Transfer Act of 1989

- Grants contractor-operated federal laboratories the authority to enter into CRDAs and license technologies to the commercial sector.

- Establishes time frames to speed up government negotiations for entering into cooperative agreements and exempts cooperative agreements from Freedom of Information (FOI) stipulations for up to five years.

(9) National Defense Energy Technology Transfer Act . Amendment to the FTTA of 1986. Nov 1989

- Strengthened emphasis and focus on federal technology transfer from DOE facilities.

4. TECHNOLOGY TRANSFER MECHANISMS & BARRIERS

4.1 Mechanisms

Historically, one of the first formalized technology transfer mechanisms, since World War II, was instituted by the National Aeronautics and Space Administration known as the Technology Utilization Program (TUP). This program represented one of the earliest (non-agricultural) federal agency attempts to address the technical needs of the commercial-industrial sector of the U.S. In a 1967 Newsweek magazine quote contained in Doctors' book on Government's role in technology transfer, German Finance Minister Franz Josef Strauss estimates "NASA programs since 1958 have stimulated almost 3,000 inventions, most with industrial potential. Every dollar spent for space research in the U.S. ten years ago is worth four times that much in economic value today" (Doctors, 1969, p.59). While this estimate may be difficult to validate, few could argue with the benefits which came out of the TUP in terms of increased understanding of the difficulties involved with establishing a comprehensive technology transfer program. Some of these difficulties are discussed later in the technology transfer barriers section of this paper.

The lessons learned from the TUP experience played a major role over the course of the decade of the 1970s while the foundation was being laid for the technology transfer legislation of the 1980s. Another benefit of this early NASA technology transfer work was recognition it helped establish for NASA as a focal point for federally funded technology commercialization. This recognition was documented in fiscal year 1990 when the U.S. Congress formally charged

the NASA National Technology Transfer Center (NTTC) as a national point-of-access to provide referrals to other federal technology transfer programs and assist in accelerating U.S. private sector utilization of technology developed throughout the federal government. (FLC News, Nov 90, p.1) This represents the latest NASA mechanism for conducting technology transfer activities.

Since the original NASA technology transfer efforts, new laws and federal regulations have been created. Under the DoD, the U.S. Department of the Air Force Regulation on Research and Development and Domestic Technology Transfer specifically identifies the following technology transfer mechanisms:

- the negotiation of patent licenses;
- other types of licenses as determined appropriate to enhance technology transfer of unclassified technology from the Air Force to society and the marketplace;
- cooperative research and development agreements (CRDAs);
- the Federal Laboratory Consortium (FLC);
- the Office of Research and Technology Application (ORTA);
- technology application assessments;
- exchange of scientific and technical personnel among academic, industrial, and federal labs, and;
- dissemination to the public and private sector of information on available products, processes, services and facilities with potential application. (AF Regulation 80-27, 31 Jan 1990, pp.1-6)

Numerous other reference articles and books list technology transfer

mechanisms similar to those identified in the Technology Access Report newsletter article by Elliott P. Levine. He indicated that "Each lab has a unique set of facilities, technology and expertise to offer industry... The mechanisms used at the federal labs often include:

- collaborative research projects;
- cooperative research agreements;
- licensing agreements;
- technology consultation;
- employee exchanges;
- use of lab facilities;
- lab visits;
- information dissemination; and
- equity participation (new)." (Levine, 1989, p.2)

The issues and interdependencies associated with each of the mechanisms identified in the previous paragraphs represent an important aspect of technology transfer which needs to be explored in subsequent extensions of this thesis. However, for the purposes of this paper, the identification of such mechanisms represents an crucial first step towards greater understanding the technology transfer processes.

Perhaps the most complete list of technology transfer mechanisms and the best outlined and indexed reference is the Guidebook for Technology Transfer Managers. The book acknowledges the "special enthusiasm, planning, and

resources" needed when managing a technology transfer from the public to the private sector. The Guidebook which was prepared by Daniel Entingh, et al, of Meridian Corporation, under a Department of Energy (DoE) contract, addresses 22 different transfer mechanisms and walks the reader through just about all the questions a manager planning to conduct a technology transfer program would want or need to ask about. What is surprisingly lacking however, is the one major area of technology transfer which is considered to be the most critical and of greatest utility to both the federal labs and the commercial sector - this is the area of cooperative research and development agreements.

Of all of the technology transfer mechanisms identified in this thesis research, Cooperative Research and Development Agreements (CRDAs) are receiving the greatest visibility and are generally viewed as the most promising. One of the main reasons is because CRDAs can combine a variety of the other mechanisms in a way which produces a synergistic effect and is mutually beneficial for both the federal laboratory and the commercial party involved. **Perhaps the most important aspect of CRDAs is their legal circumvention of the cumbersome (red tape) of the Federal Acquisition Regulation (FAR).** By Congressional design, laboratories which enter into CRDAs do not have to comply with the FAR because these regulations only apply to procurement contracts and a CRDA cannot be a procurement contract. By definition, a CRDA is "Any agreement between one or more federal laboratories and one or more non-federal parties under which the Government, through its laboratories, provides personnel, services, facilities,

equipment, or other resources with or without reimbursement (but not funds to non-federal parties); and the non-federal parties provide funds, personnel, services, facilities, equipment, or other resources toward the conduct of specified research or development efforts that are consistent with the missions of the laboratory; except that such term does not include a procurement contract ... and as such the Federal Acquisition Regulation (FAR) and the DoD FAR Supplement are not applicable to these agreements." (DoD Reg.3200.12-R4, p.iv)

Although the awareness level, both within the Government labs and commercial industry, of these recently authorized technology transfer opportunities is still low, more and more commercial sector companies are learning to tap into the technical knowhow at the 700 plus Federal labs. In an article written by Denise Kearns several recent CRDA examples are identified. The article indicates federal labs are teeming with R&D opportunities. Clifford Thompson, Director of Bioproducts for Dow Chemical Company, interviewed for the article, states "Government laboratories have always presented a huge potential resource. The difference today is in the ability and willingness of laboratories to open their doors to industry, negotiate patent rights and enter into flexible licensing agreements." The original Federal Technology Transfer Act in 1986 and subsequent amendments and new legislation each year since then, has made possible this incredible flexibility and has truly opened the doors of opportunity for tremendous Federal lab and commercial sector interaction through these CRDAs. In Kearns' article, she goes on to quote Ed

Mead, Manager of Business Development in Du Pont's Central Research Division. Mead says that "Du Pont is dipping into the federal research trove. In 1988, Du Pont assigned three senior managers to scout the federal labs for opportunities. The result: Du Pont is participating in several CRDAs in the areas of advanced materials and measurement technologies." Having recently entered into a three-year, \$11 million CRDA with Los Alamos and Hewlett-Packard, Du Pont believes that their cooperative efforts will pay off from their development of thin-film, high-temperature superconductors for commercial products in communications and instrumentation. (Chemical Engineering, 1990, Vol. 97, No. 4, p.45)

In summary of this section on technology transfer mechanisms, of all of the transfer mechanisms identified, the cooperative research and development agreements (CRDAs) are perhaps the most important new mechanism available. Optimism concerning the use of CRDAs exists across the board, from the top executive ranks in this country to some of the largest and most recognizable U.S. commercial sector organizations. The potential of CRDAs as a "dominant design" in U.S. Federal technology transfer activities is of such importance that it will be analyzed in greater detail in subsequent chapters of this thesis. The next section will address some of the barriers associated with transferring technology from these federal laboratories to the commercial sector.

4.2 Barriers

In the seminal federal technology transfer book by Doctors, he stated, "There are many barriers to [federally funded technology] transfer. They are found in the mission orientation of most agency technical personnel, in the vertically integrated nature of the agencies, in the conflicting policies concerning the legal rights to patentable inventions and other proprietary data among the agencies, in the institutional barriers to information flow in the aerospace/weapons-systems industry, in the low rate of technologist mobility from the aerospace/weapons-systems industry to the commercial sector, in the low value placed on the transfer function by the scientific and technical personnel engaged in the federally sponsored R&D, in the political nature of institutions for transfer, in overzealous security restrictions, in poor and antiquated methods of information retrieval and evaluation, in poor understanding of the transfer process, and in the very power structure of the [federal] agencies themselves." (Doctors, 1969, pp. 8-9)

From the NASA Technology Utilization Program, which was a staff organization, the U.S. learned of the need to delegate the responsibility and authority for conducting technology transfer to the line organization or laboratory science-technology oriented department. From this early work, NASA, and hence the greater U.S. technical community, learned that "NASA does not operate in a self-contained environment." (Doctors, 1969, pp. 159-162)

Here again, the importance of interaction between the federal and commercial-industrial sectors is emphasized. While there are still many internal

barriers (i.e., cultural, procedural, etc.) at the many federally funded research facilities which must be overcome, many of the critical barriers deal with the external interface between the laboratories and the commercial sector. Two of these external barriers are perceived conflict-of-interest and equal opportunity or fairness of access to federal researchers and facilities.

Concern over potential conflict of interest (COI) on the part of federally funded researchers also presents a type of barrier for conducting technology transfer. In their efforts to proceed cautiously with their implementation of technology transfer initiatives, many federal agencies are attempting to develop guidelines to minimize or preclude the damage to the organization during increased exposure to and interactions with industry. During 1989, the National Institute of Health (NIH) drafted a set of COI guidelines which essentially negated the benefits of the technology transfer legislation. Although these guidelines were ultimately withdrawn, their initial circulation for coordination and approval heightened the greater community awareness of such guidelines as a barrier. (NIH Draft Policy Statement, 1989)

Another significant barrier has been the inability of federally funded research organizations to patent and retain the rights to their research results. However, criticism from federal contractors and government laboratories about the patent and license policy allowed Government officials to develop refinements in current legislation which allows for the retention of full rights for the Government funded research organization. These federally funded organizations also typically have the delegated authority to selectively choose

whom they will license the technology to. This, however, highlights another barrier which the labs are struggling with concerning equal opportunity of access to the research and fairness of selection of cooperative research partners.

An additional barrier to technology transfer, and one which must be weighed with the utmost care, deals with national security. In his essay entitled *Technology Transfer: A Policy Model*, Philip Roberts addresses national security considerations. Roberts states "on the one hand, sharing new information in areas such as energy generation or irrigation can improve the general welfare. However, the spread of technology with military applications ultimately can damage a nation's defenses. For this reason, and because of potential dangers it presents to national economic interests, "technology transfer" has become something of a *contentious concept in international relations.*" (Roberts, 1988, p.xii)

In summary of this section on barriers, there are many types of barriers to overcome concerning domestic technology transfer. From the perspective of a federal laboratory attempting to comply with the intent of new federal legislation and agency regulations, some of the most pressing issues and barriers are the concerns over conflict of interest; equal opportunity of access and fairness in establishing cooperative research and development agreements; and a host of national security issues which span the range of barriers from purely political to those dealing with competitive advantage (i.e., including both military and commercial critical technologies). The perceptions of these barriers will be

discussed in subsequent chapters of this thesis and each will be assessed concerning how they can best be dealt with to enhance technology transfer through cooperative research and development agreements.

5. DATA ANALYSIS PLAN

The determination of which data to collect, how to collect it and how to analyze it was guided by the literature research and preliminary meetings with thesis advisors. The specific design of this research effort was accomplished by asking a number of questions concerning the objectives of the research and by analyzing the answer to each question to determine the underlying drivers or elemental factors. The question stream used to develop the research methodology flowed something like this:

Q1. What can be done to enhance the transfer of technology from U.S. federal labs to the domestic commercial sector?

A1. Design, develop and implement policies, processes and procedures which strengthen cooperative research and development between the labs and their potential commercial sector partners.

Q2. How can cooperative research and development enhance technology transfer?

A2. By utilizing relatively new legislation authorizing laboratories to sign agreements with commercial sector partners who agree to conduct R&D activities which are mutually beneficial to all signatories and capitalize upon the strengths and capabilities of each partner.

Q3. What are these Cooperative Research and Development Agreements (CRDAs) and how are they developed?

A3. A CRDA are simply a documented agreement between a laboratory and one or more public or private sector partners. They can be as simple or as

sophisticated as need be to accomplish the R&D activity and protect the intellectual and property rights of all participants. They are developed through a series of negotiations between federal labs and commercial companies (typically).

Q4. What are these negotiations and who participates in them?

A4. The negotiations are simply to establish and document the objective(s) of the cooperative effort and identify who the parties to the agreement are and what each will contribute in terms of personnel, equipment, facilities and funding. The main participants in the negotiation process typically involve a principal engineer or scientist for each organizational entity; technology transfer facilitators or specialists; legal counsel for addressing intellectual property rights; laboratory or corporate management; and the federal laboratory sponsor as a final review authority.

Q5. Since these CRDAs seem to be rather dependent on this negotiation process, what can be done to enhance these negotiations and improve the probability of a successful technology transfer effort?

A5. Research the details of the CRDA negotiation process; study formal negotiation theory and identify applicable aspects, and; develop an understanding of the perspectives of the various key participants. Then use this insight to analyze the process and identify areas for improvement.

This is the series of questions and answers which were addressed to design a procedure for conducting this thesis research. Armed with a better understanding of what the published sources believed the major technology

transfer factors, mechanisms and barriers were, three hypotheses were developed.

5.1 Hypothesis definition

Based upon the overall research objectives and the anticipated accessibility and availability of key technology transfer participants, the principal hypotheses to be investigated were defined as follows:

H1: Awareness is still a key issue. The level of awareness of technology transfer opportunities perceived by private industry, federal lab management and lab research staff is expected to differ by segment; and that this difference forms a communication barrier which further impedes technology transfer progress.

H2: The perception of government "red tape" is a major barrier. While government-industry relationships for cooperative research and development are not bound by the familiar government acquisition & contracting regulations, many potential technology transfer participants are expected to perceive the new opportunities as having the same (contractual) constraints.

H3: Understanding and enhancing the negotiation process between the labs and commercial industry is a key to successful technology transfer through cooperative research and development. To this end, the perspectives of the main participants need to be better understood.

To investigate these hypotheses a structured interview questionnaire was

prepared. This questionnaire was then delivered personally, either through face-to-face meetings or via telephone interviews to roughly 70 individuals who were selected from the various groups previously identified as key participants. The distribution of the participants is as shown in Figure5-1.

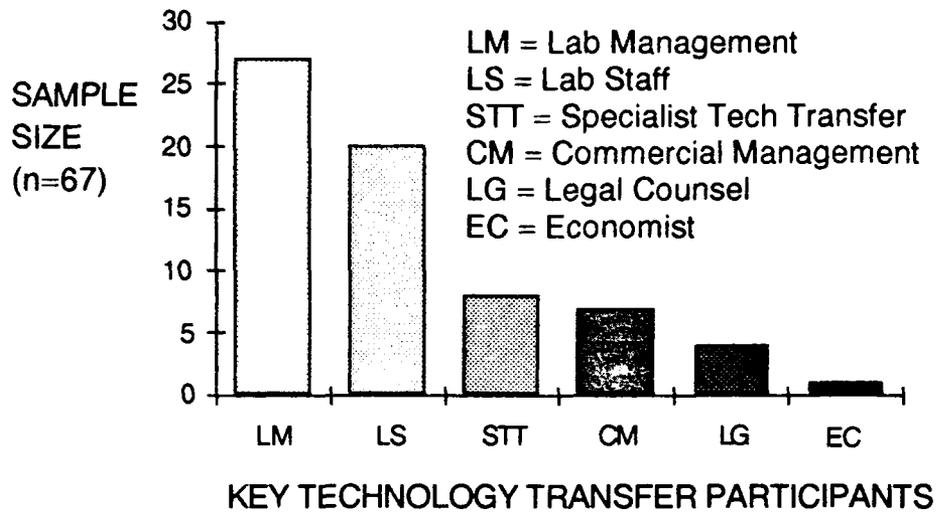


Figure 5-1: Distribution of Interview Participants

For the most part, the individuals sampled were selected randomly. For the federal labs selected, the majority of research staff members selected were chosen randomly from internal phone directories and lists. Many of the laboratory managers were also selected randomly. However, to ensure sufficient information from laboratory managers on the detailed technology transfer processes, some were identified by name with the guidance of higher level lab managers or technology transfer specialists. To sample technology

transfer specialists, each of the federal labs or research facilities were represented by at least one individual. In addition to the laboratory specialists, technology transfer specialists from other federal and technology transfer non-profit organizations were interviewed to gain additional perspectives and insights based on a broader range of experiences. In selecting the commercial sector participants, only a couple were identified by name as the counterparts of a past or ongoing technology transfer activity. This was intentionally done to have data which represented both perspectives of a specific technology transfer or cooperative research and development activity. However, the majority of commercial industrial sector representatives were chosen at random and their participation was based almost entirely upon ease of access and availability. The legal counsel or patent attorney representatives interviewed were selected based upon recommendations and referrals from the other federal and commercial participants.

These interviews were personally conducted in either face-to-face meetings or through telephone conversations. Each interview lasted between 10 minutes to 2 hours with an average interview time being approximately 25 minutes. The interviews were documented initially as hand written notes. The notes were then immediately typed into a word processing file on a Macintosh computer. For ease of manipulation and data analysis, this information was subsequently summarized and transferred to a data base where it could be sorted and viewed in a number of ways, e.g., sort by position of individual interviewed and list the number of positive responses. Appendices A and B are

the forms used to interview the federal laboratories and commercial sector participants respectively. Appendix C is a sample of sanitized (to preserve anonymity) interview raw data sheets (as transcribed from notes). Appendix D contains the entire summarized data base entries (from the raw data).

6. RELATIVE ASPECTS OF NEGOTIATION THEORY

During the course of conducting background research and reviewing the available literature on the subject of technology transfer, it became increasingly apparent that the only viable methods involved close cooperation between the key participants. As the research and review continued, the most promising mechanism available for transferring the technology was distinguished. This mechanism is the Cooperative Research and Development Agreement (CRDA). Likewise, in the process of collecting, reviewing and analyzing all related materials on CRDAs, the importance of understanding the negotiating process became a central theme. To this end, the research has focused on studying the various negotiation theories, tactics and guidelines. While not all negotiation theory is applicable to the activities related to transferring technology, much of the theory associated with the "win-win" negotiated outcome is applicable.

The negotiation theory associated with the win-win situation, sometimes referred to as integrative bargaining, is an essential component of the CRDA development process. The alternative is the win-lose situation, which is frequently called distributive bargaining and places the participants in a head-to-head competition for the subject of the negotiation. While this win-lose tactic may work for some scenarios requiring a one time, short-term negotiation for a specific item (e.g., purchasing a car), it typically will not provide the level of cooperation, enthusiasm and optimistic outlook required for negotiating a cooperative R&D agreement. When thinking about which type of negotiation strategy to use, remember, "Every negotiator has two kinds of interests: in the

substance and in the relationship." (Fisher, p.20) Keep in mind that when trying to establish a long term relationship of the type necessary for effecting technology transfer, sometimes the outcome of any particular negotiation will be less important than the potential of maintaining a good working relationship.

Additional aspects of win-win negotiations or integrative bargaining which are relevant to the coordination and development of CRDAs include the fact that the participants in the process are or should be seeking opportunities for mutual gain. During the negotiation process, progress should be measured to ensure effective and efficient resolution of the matter under consideration. On the subject of negotiation process evaluation, a noted author states that, "Any method of negotiation may be fairly judged by three criteria: It should produce a wise agreement if agreement is possible. It should be efficient. And it should improve or at least not damage the *relationship between the parties*. A wise agreement can be defined as one which meets the legitimate interests of each side to the extent possible, resolves conflicting interests fairly, is durable, and takes community interests into account." (Fisher, 1981, p.4)

In his book on the Fundamentals of Negotiating, Nierenberg recommends thinking "of negotiation as a cooperative enterprise. If both parties enter the situation on a cooperative basis, there is a strong likelihood that they will be persuaded to strive for goals that can be shared equally." (Nierenberg, 1987, p.22) One of the greatest strengths of the CRDA lies in its name - Cooperative Research and Development Agreement signed by two or more individuals representing two or more companies. The cooperative part of a CRDA sends

an important image to prospective commercial companies contemplating the establishment of a close working relationship with the government and government employees.

This highlights another very important aspect of negotiations, the fact that these cooperative agreement negotiations involve the commitment of individuals. In his book entitled Getting to Yes, Fisher states that, "Negotiations are people first. A basic fact about negotiation, easy to forget in corporate and international transactions, is that you are dealing not with abstract representatives of the 'other side,' but with human beings. They have different backgrounds and viewpoints; and they are unpredictable." (Fisher, p.19) This is one of the reasons why it is so important to understand the perspectives of the key participants involved in the development of a CRDA to transfer technology. In addition, concerning perception, Fisher notes, "Understanding the other side's thinking is not simply a useful activity that will help you solve your problem. Their thinking is the problem. Whether you are making a deal or settling a dispute, differences are defined by the difference between your thinking and theirs." (Fisher, p.22)

Understanding their perspective may be as complex as researching a corporation's background or an individual's past business dealings. Or it may just be as simple as putting yourself in their shoes. "How you see the world depends on where you sit. People tend to see what they want to see. Out of a mass of detailed information, they tend to pick out and focus on those facts that confirm their prior perceptions and to disregard or misinterpret those that call

their perceptions into question... The ability to see the situation as the other side sees it, as difficult as it may be, is one of the most important skills a negotiator can possess... you need to understand empathetically the power of their point of view and feel the emotional force with which they believe in it."
(Fisher, pp.23-24)

It's important to recognize that during any negotiation , surprises can occur and difficulties can arise. However, by having a better understanding of the perspectives of the other key participants, alternatives can be suggested which accommodate their needs and satisfy your objectives as well. To expand upon that thought, the next chapter will address specific details of the various participants involved in the technology transfer process.

7. PERSPECTIVES

One of the keys to enhancing technology transfer through cooperative research and development is to better understand the perspectives of the key participants in the process. This same sentiment is echoed by Axelrod in his book entitled The Evolution of Cooperation, where he states that, "Understanding the perspective of a participant can also serve as the foundation for seeing what can be done to make it easier for cooperation to develop..." In their book entitled Marketing Warfare, by Ries and Trout, they note that "Perception affects taste in the same way that it affects all human judgement. The battle takes place in the mind. There are no facts in a human mind. There are only perceptions. There perception is the reality." To acknowledge the reality of differing perspectives and perceptions in cooperative R&D arrangements, or any other type of negotiation, is to recognize the importance of learning how to incorporate these differing views into our own plans and strategies for achieving mutually beneficial objectives. Therefore, this section of the thesis addresses the various perspectives and perceptions with the hope of gaining insights which will allow greater understanding to promote fuller cooperation in future technology transfer activities.

7.1 Commercial management perspective

7.1.1 Main thoughts

To understand the management perspective of U.S. commercial industry seven questions were asked. A random sampling of commercial management

with position titles such as corporate chief executive officer/ president, vice president technology, vice president for R&D and laboratory director were selected. The following paragraph represents a composite summary of their thoughts concerning the prospect of working, that is conducting some level of research or development, with a U.S. federal laboratory:

The federal laboratories represent a large number of independent labs which are in general insulated from industrial sector. Although the national labs may represent a great opportunity, national expertise and in some sense a member of our industrial R&D family, they tend to get bogged down over time. *In doing "business" with the federal labs there are difficulties concerning monetary transfers. Also, there are accounting constraints which limit our flexibility and responsiveness. But perhaps the most significant concern is the confusion of ownership of intellectual property and the inability of the federal lab to protect company property.* In general two words summarize working with the federal labs - RED TAPE. Figure 7.1 summarizes the commercial managements' feelings and various awareness aspects of performing technology transfer activities or conducting cooperative research and development with a federal laboratory.

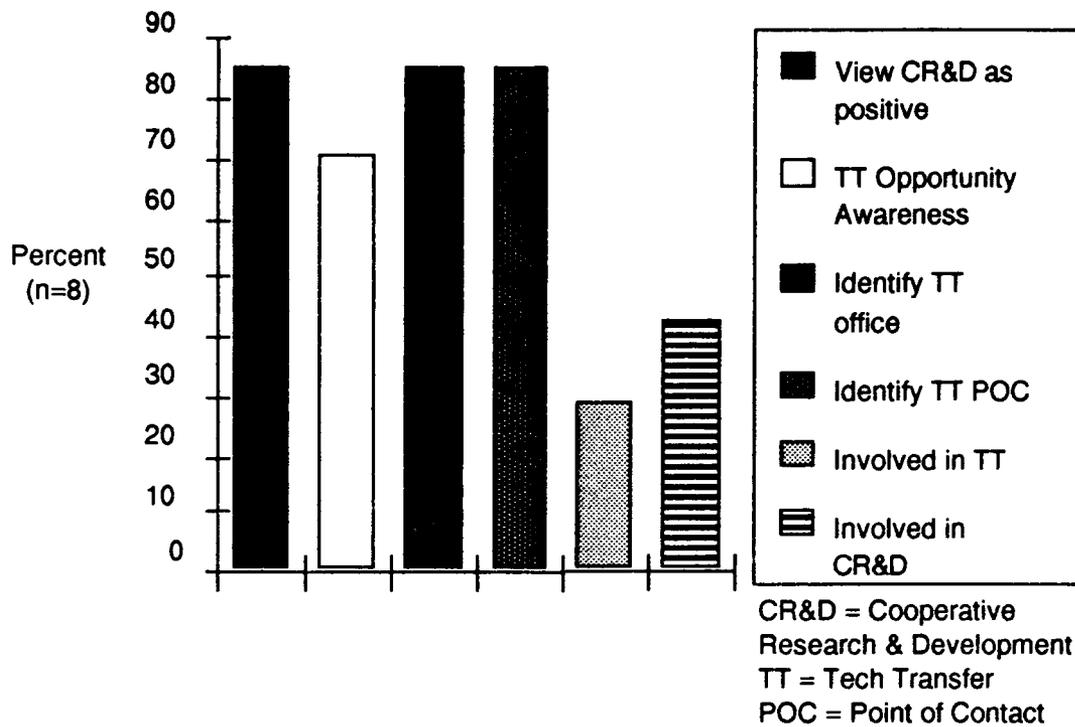


Figure 7.1: Commercial Management structured interview responses

7.1.2 Feelings about cooperative R&D

In general, the commercial industry management presents a rather skeptical image concerning the prospect of conducting R&D with a federal laboratory. The second question asked of each commercial representative was "How would you feel about conducting cooperative research and development with a federal laboratory?" For each respondent, the term "cooperative R&D" was defined as previously indicated and their comments were documented. In spite of the skeptical image portrayed by this sample of industry, there were no negative responses, 14% were uncertain and 86% indicated a positive or interested response.

7.1.3 Barriers perceived

The third question asked of the industry participants was "What do you personally view as the top two or three barriers to conducting cooperative research with the federal laboratories?"

The answers can be grouped into four categories which include:

- a. Communications and information flow
- b. Laboratory lack of consideration of commercial interests
or financial needs
- c. Lack of experience with lab technology and in negotiating
agreements
- d. Lack of effective technology transfer mechanisms

Representatives of commercial management indicated that there is a real problem with information flow. It's difficult to know what's going on in labs. Communication sharing difficulties are compounded by the typical geographical separation which forms a physical barrier to technology transfer.

A second perceived barrier is the concern over the potential for significant flow of profit. It is frequently difficult to determine whether or not an internal R&D project is going to payoff. The difficulties tend to be compounded when a substantial portion of the effort is performed externally. Commercial managers are also concerned about the financial exchange arrangements and the fact that the funded technology may not always be developed with commercial interests in mind. Then, there is the question of intellectual property rights.

How will these be negotiated and can the government be trusted to live up to their end of the bargain?

A third area of concern is the basic lack of experience in working with the labs in this manner. There is no track record to give industry confidence in the process or value of technology involved. Barriers perceived include the necessity to get lawyers involved in working out the details of the negotiations. If caution is not exercised, these cooperative efforts may start to look a lot like the historical contractual arrangements between government and industry

Finally, the commercial management perceived that mechanisms for getting data about new technologies out of the labs in timely way doesn't exist. There is also a problem perceived with the reward system for motivating the managers and research staff to accomplish this type of cooperative activity. These problems apparently exist on both sides, *government and industry*. The Federal Laboratory Consortium (FLC) was acknowledged as a potential transfer assistance mechanism, but was identified as lacking sufficient manpower to the job effectively.

7.1.4 Opportunity Awareness

The fourth question asked of the commercial industry representatives was "Are you aware of any recent opportunities and/or guidelines concerning cooperative R&D or technology transfer from the federal laboratories to the private commercial sector?"

five out of seven or 71% indicated some level of awareness of recent

opportunities brought about by federal legislation. The level of awareness ranged from fairly detailed and in some cases practical knowledge to a vague familiarity based upon recent readings. As a follow-up question to those industrial managers who were familiar with the opportunity, I asked whether they knew who to contact, within their own organizations, for additional information and/or help in conducting such (technology transfer or cooperative R&D) activities. All but one of the industrial respondents indicated that they did know who to contact for more information and could in fact provide a specific individuals name as a point-of-contact (POC).

7.1.5 Involvement

Probing beyond the level of awareness, I asked each commercial participant "Are you now, or have you been involved in either a technology transfer or a cooperative R&D effort with a federal laboratory?" Here again, four out of seven respondents indicated that they either were or had transferred technology from a U.S. federal lab. Only one out of seven or 14%, however, indicated that they had actually participated in a cooperative research and development (formally or informally) with a federal laboratory. In addition, the data collected indicated that roughly 43% of the industrial questionnaire respondents had not participated in either a technology transfer activity or any form of cooperative R&D with a federal sponsored laboratory or research facility.

7.1.6 General comments

At the conclusion of the structured interview of each commercial

representative, I asked an open ended question to uncover any important observations or specific areas of interest which might have surfaced during the questioning but were not specifically addressed. The following paragraph is a composite sampling of those general comments which were felt to be most important:

Communication between the laboratories and the commercial sector definitely needs to be improved. There needs to be a greater awareness and understanding of mutual needs and capabilities. As a profit making entity, commercial companies also need to know if the government is funding the technology transfer process and/or mechanism implementation. Who is going to pay for the process? How seriously is the government committed to making it work. It seems that opportunities could exist to combine or extend some of the industry sponsored research at universities to the federal laboratories. This may in fact already be occurring at some of the unique federally funded research and development centers. Finally, there remains the possibility that in the process of enhancing technology transfer via cooperative research and development agreements, and through the offering of exclusive relationships with any single company; the delicate balance which now exists between the federal laboratories and the mutually beneficial - interactive - relationship could be spoiled by one of perceived competition. This would not serve the laboratories, the industrial companies, or the nation very well.

7.2 Laboratory management perspective

7.2.1 Main thoughts

Laboratory management represents another one of the key groups of participants in the technology transfer process. For the purposes of this study, management was defined by two criteria: first, not currently functioning on the research staff (hands on, actually conducting R&D), and; second, responsible for oversight of some quantity of research staff (i.e., branch chief, group leader, division head, etc.) The leadership and guidance provided with proper emphasis from this segment of laboratory human resources, can lead to a successful implementation of a new or improved technology transfer program at each respective laboratory. Therefore, it is important to understand laboratory management's perspective on how they view commercial industry. To this group of lab managers, the question "When you think of working with industry, what thoughts or images come to mind," where the term 'working with' was defined to be conducting some level of R&D activity. The following paragraphs summarize the key points identified by 27 laboratory management respondents from two large federal laboratories:

- a. **Complementary:** The level of expertise is comparable to that which resides in the federal labs and is complementary in nature. The commercial industrial sector is perceived to have a "deep bench" which can provide wide scale support which complements the federal laboratory capabilities. We welcome support from industry.
- b. **Profit motivation and variable quality:** These two characteristics of the commercial companies make it necessary that the federal laboratories proceed

with caution. The quality of research available in the commercial sector is company dependent. This variable quality level indicates that when and if we do interact with an industrial partner, we need to carefully choose that partner. Industry is profit driven. This profit motivation induces communication difficulties which can impede the interactive process between labs and the commercial sector.

c. Internal laboratory impediments: Within the labs, there is a low cultural impetus for transferring technology. There is a willingness on lab's part to do technology transfer, but there is great difficulty in doing it. There are several reasons for this. First, the labs are not familiar with industry. They don't usually know what industry's needs or requirements are. Second, industry doesn't do a lot of what the labs do. In the labs, they are typically involved with research which may be unique and of no immediate commercial interest. Third, if the labs are to work with industry, they must become faster at what they do. The stereotypical view of long R&D cycles associated with federal labs must be dispelled if the labs are to attract industry's interest. Fourth, there are new barriers such as concern over preferential treatment, equal opportunity of access and situations which position the lab as a potential "commercial competitor" which must be addressed to enable greater interaction with industry. Finally, it is essential for the labs to better understand the commercial industrial community's perspective in order to achieve greater level of successful interaction.

d. Related to the cultural issues identified above are the laboratories' contract

oriented approach to working with the commercial industrial sector. Although there is a long history of informal cooperation, the historical attitude of making sure industry meets the laboratories "contract research" and equipment or materials supply requirements is a dominant feature related to the majority of laboratory respondents. This attitude should not be a surprising one since it has been the primary formal mechanism for laboratory-industry interactions for some 40 years. There is some recognition at the laboratory management level, however, that both the laboratory and industry culture must change and be willing to "invest" time and effort to overcoming this procurement oriented mentality and improve the professional research and development working relationship. Greater opportunities for formal interaction now exist than were previously believed to be possible. Many lab managers view the possibility of commercializing a federal lab "product" as a interesting idea which may stimulate research staff creativity. Figure 7.2 summarizes the laboratory managements' feelings and various awareness aspects of performing technology transfer activities or conducting cooperative research and development with a commercial entity.

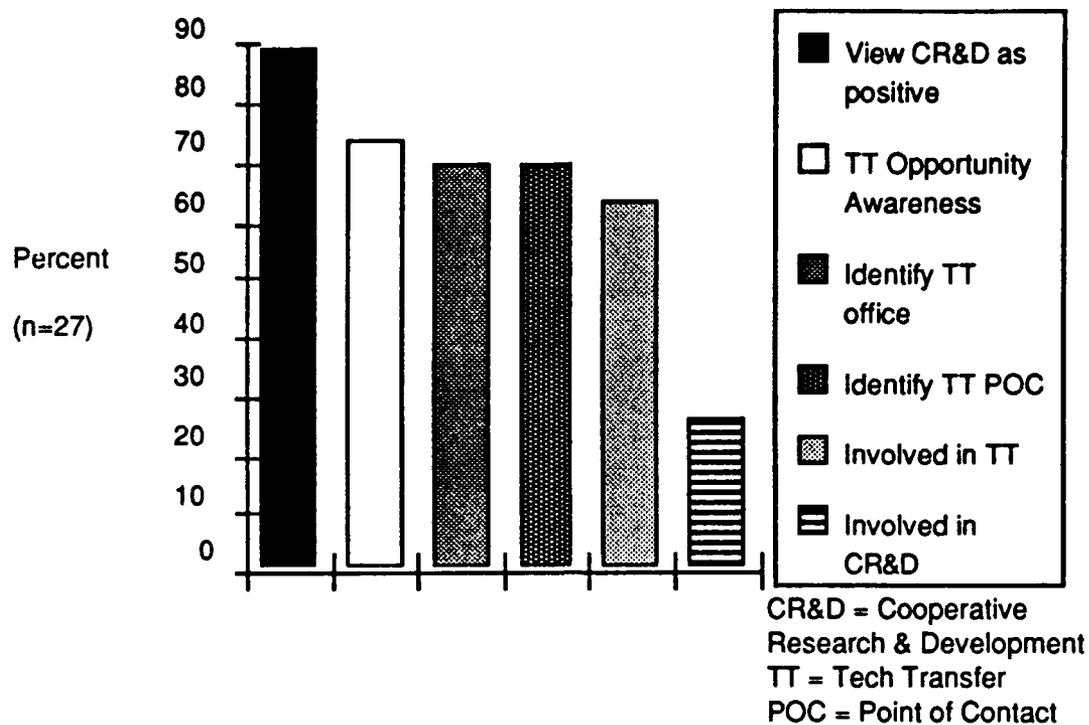


Figure 7.2: Laboratory Management structured interview responses

7.2.2 Feelings about cooperative R&D

When the laboratory management interviewees were asked the second question of "How would you feel about conducting cooperative research and development with industry?" their responses were documented and tallied. Here again, the term "cooperative research and development" was defined for each individual as a research process in which the lab would contribute personnel, equipment, facilities and direct lab funding of the internal effort, and the commercial partner would/could contribute personnel, equipment, facilities and/or funding to the laboratory to conduct R&D which is mutually beneficial to both the lab and the commercial entity. An overwhelming 89% indicated a

positive or favorable response and the vast majority of those had visual or audible characteristics of true excitement. Only two of the twenty-seven respondents were clearly uncertain and only one individual perceived it as negative.

7.2.3 Barriers perceived

Next, the federal laboratory management interviewees were asked to answer the question of "What do you personally view as the top two or three barriers to conducting cooperative R&D?" The following paragraphs represent a grouping of their responses by similarity of content:

a. Challenges of negotiating the cooperative agreement.

Of the 71 responses compiled (typically 2-3 per person), 28% referred to a potential barrier associated with negotiating an effective, efficient and equitable cooperative research and development agreement. Within this category, the principal concerns were:

- 1) proprietary information issues, ownership of technology and patent protection
- 2) legal obstacles and the potential "problems" associated with having a lot to do with lawyers and the coordination of physical arrangements and mechanisms
- 3) the details of the arrangements, the implementation details and negotiating positions of the lab and the commercial enterprise
- 4) coming to agreement on levels of research funding that makes it worth

the effort of both parties and identifying who pays for any specific technology transfer effort

5) the need for quid pro quo and a truly cooperative research effort which would be mutually beneficial; and the recognition that such activity takes a lot of time and effort and both parties need to be motivated

6) concern about industry taking advantage of government facilities without equitable compensation

b. Laboratory administration and culture.

This category highlighted some of the perceived problems either existing or expected to surface due to current laboratory administration and culture. Here again, 28% of all laboratory management responses identifying barriers to cooperative R&D were in this category. The main concerns relating to this category are as follows:

1) The philosophy of lab management is still a problem - we don't really have their blessing to do this type of tech transfer. The top level lab policy is unclear and there's a lack of experience and positive attitude about dealing with it.

2) The lab is not structured to provide technology transfer to the commercial sector. We don't know how to do it within the confines of our lab structure. The theory seems to call for a new lab bureaucracy, but there is no funding to do the job.

3) There are major questions of fairness on how to select companies for

CRDAs. This whole fairness issue is one of equal opportunity of access. Inappropriate handling of this could lead to a perceived conflict of interest. We need to have rules up front about this type of technology transfer.

4) We need to change our way of thinking. We're struggling against a historical bias - we've never done it (formal cooperative research) before. There is no history for the process.

5) There are several important miscellaneous issues. There must be corporate sponsorship - that is, the lab's primary mission research sponsor must see cooperative research as good and be supportive. We have different cultures and communication patterns to contend with. We also have to fight against the not-invented-here (NIH) syndrome. And finally, there are differences in the laboratory pay scale and salary level as compared with commercial industry. This difference in compensation may cause unanticipated problems as we enhance interaction and cooperation over sustained periods of time.

c. Insufficient level of awareness - multiple aspects.

This research indicates that 10% of the laboratory management participants believed that the lack of or level of awareness is a major barrier to effective technology transfer through cooperative means. The two principal types of awareness include the lab awareness of external commercial needs and potential partners, and; the commercial sector awareness of federal laboratory technologies, facilities and expertise. Some of the specific barriers identified in this research include:

1) There is no effective or well understood means for increasing industry awareness of laboratory technologies. There is the overriding concern about providing equal opportunity of access to lab technology.

2) There is the perceived difficulty of knowing which companies to approach as complementary industrial cooperative partners.

3) There is also concern that existing organizational offices and mechanisms are insufficient or not properly organized to provide the labs with the kind of specialized technology transfer support they need to conduct this type of cooperative research and development.

d. Industry's general short term perspective.

The fourth barrier, which was also noted by 10% of the laboratory management segment of research participants, was the impact as a result of industry's short term perspective as it relates to R&D. The results of this research indicate that there is a perceived risk averse nature of the commercial sector which tends to limit their willingness to make long term investments in many things including R&D. Some laboratory management participants accredit this to the general nonavailability of resources for long term research. Others interviewed indicate a sense of irritation over the "backward" industrial management practice of focusing on the short term at the expense of long term investment. This is also consistent with others interviewed who perceive a sense on industry's part that the cooperative effort just won't lead to profits. A final interesting observation is that a barrier exists within the lab due to the perception that the industrial security of the research results may be

compromised due to the instability of the commercial sector (e.g., companies going out of business during a cooperative research effort or being taken over by a less than satisfactory partner thereby spoiling or delaying the opportunity for successful commercialization of the technology.) profits

e. Concern over lab's loss of influence or control

The perception that the laboratory's ability to maintain control over the direction and results of the research was identified as a barrier to cooperative R&D by 7% of the lab management participants. Cooperative R&D with a commercial organization would only be performed if there is sufficient expected benefit to the company in terms of research which leads to a final commercializable product. To achieve this without providing substantial benefit to the company's competitors would require a limited distribution of research results. These anticipated constraints on publication are examples of the loss of influence or control which will be difficult for the federally funded laboratory scientist or engineer to forego. Additional constraints on the federal lab personnel are expected to be imposed in the form of nondisclosure agreements. These agreements are formal documents which are intended to protect the proprietary technology of the laboratory's commercial partner(s). However, to some extent these nondisclosure agreements are viewed by the federal lab personnel as constraints which tie their hands and force them to sacrifice some independence and control.

f. The potential for perceived loss of lab objectivity.

Originally perceived by some interviewees as one of the top barriers to

technology, the perceived loss of lab objectivity was identified as a primary concern in only 4% of the responses. Included in this category are the related issues of forming laboratory-industry competitive alliances and the potential for loss of the existing unbiased status or privileged third party position.

g. Confusion of cooperative R&D efforts and procurement.

Four percent of the laboratory management participants expressed some confusion between the government acquisition procurement system and technology transfer efforts. This is not surprising since the major formal mechanism for technical interactions between industry and the laboratories has been the contractual process as guided by the Federal Acquisition Regulation (FAR). Some of the specific comments identifying the procurement system as a technology transfer barrier included thoughts such as:

- 1) The procurement system doesn't encourage technology transfer;
- 2) The federal procurement regulations are too rigid; and,
- 3) There is concern over satisfying conflict of interest (COI) requirements as defined in the FAR.

h. In addition to the principal barriers identified above, 9% of the comments related to a number of miscellaneous thoughts or concerns. A couple research participants were very optimistic about cooperative R&D with industry and indicated that there were no fundamental barriers to making it happen. One lab manager frankly stated that "since we're not doing it officially, nothing gets in the way." Others though had concerns about competition, security and the unique aspects of federal lab R&D efforts. One individual

described the difficulties associated with perceived competition with the commercial sector. However, this was clarified to mean "perceived competition for available federal R&D funding." To some extent, it was noted, the labs create their own competition for R&D funding. As technology R&D activities progress, frequently the labs will "spin-off" the more advanced technologies to the industrial community - frequently transferring (i.e., losing) the scientists and/or engineers most intimately involved with the R&D effort. This external commercial organization can become a "competitor" in a sense for future government grants or R&D funds for further development. This is normally a healthy process which is reportedly encouraged as a technology transfer mechanism by top level lab management, but can in fact be viewed as a type of barrier depending on exactly where you are in the management structure. The remainder of respondents in this category believed there are applications issues act as barriers. This includes instances in which the sometimes specialized laboratory experience is simply not needed in commercial sector and therefore there is not perceived to be any relevant technology or expertise to be transferred.

7.2.4 Opportunity awareness

The fourth question asked to the laboratory management representatives was "Are you aware of any recent opportunities and/or guidelines concerning cooperative R&D or technology transfer from the federal laboratories to the private commercial sector?"

Twenty out of twenty-seven or just over 74% indicated some level of awareness of recent technology transfer opportunities as a result of internal policy, procedures/guidelines or federal legislation. Here again, as with those surveyed from commercial management, the level of awareness ranged from fairly detailed and in some cases practical knowledge to a vague familiarity based upon recent readings.

A follow-up question, posed to those lab management representatives who stated some awareness of new opportunities, was if they knew who to contact, within their own organizations, for additional information and/or help in conducting such (technology transfer or cooperative R&D) activities. Over 70% of the lab managers interviewed were able to correctly identify the organization's designated technology transfer office or point-of-contact (POC). Eight lab managers, or nearly 30% indicated that they did not specifically know who to contact for more information and were unable to provide an office or individuals name as a technology transfer POC.

7.2.5 Involvement

To discern the level of laboratory management involvement in either technology transfer or cooperative research and development activities, the interviewees were asked "Are you now, or have you been involved in either a technology transfer or a cooperative R&D effort with a commercial company?" Seventeen of the twenty-seven or 63% of the respondents indicated that they either were or had transferred technology from a U.S. federal lab to the

commercial sector. Only 26%, however, indicated that they had actually participated in a cooperative research and development (formally or informally) with a commercial company. In addition, the data collected indicated that 26% of the laboratory management respondents had not participated in either a technology transfer activity or any form of cooperative R&D with a commercial industrial company.

7.2.6 General comments

The final question asked was open ended to uncover any important observations or specific areas of interest which might have surfaced during the questioning. The following paragraph is a composite of those general comments which were believed to be most representative:

The majority of the general comments can be grouped into four loosely bounded categories as follows:

- Awareness;
- Sponsor and lab management strategy;
- The technology transfer process itself; and
- Technology transfer barriers

On the awareness issue, it was generally believed that greater awareness of this type of formal cooperative research and development activity with commercial industry could help improve the low technology transfer output from the lab. It was also observed by the lab management representatives that the

general level of awareness of opportunities for technology transfer within the lab is an issue. However, many also believed that it is difficult to be aware of let alone quantify all aspects of technology transfer, and that publicizing of lab technology and ideas externally hasn't been very successful. Finally for the sample of representatives from the government operated, federal employee, laboratory, it was noted that technology transfer was not in their official job descriptions so there is no emphasis or focus on that activity for performance evaluations or promotions as required.

On the subject of research sponsor and lab management strategy for domestic technology transfer, there is concern over lab sponsors approval and the level of encouragement from the government and senior lab management. Historically, mixed signals have been sent from the government sponsors to the labs concerning their level of formal interaction with industry. This has made it difficult for the labs to address cooperative research and development as part of lab strategy. A final observation by this group of lab managers is that some form of motivation is necessary for the labs to do more technology transfer and this requires the "correct" management attitude to allow the research staff to interact more with industry.

Concerning the general comment that the problem is the technology transfer process itself, it is believed that the government should devise a system to encourage an early industry role in the process. Some researchers have noted that there is a need for a mechanism to solicit reverse proposals from industry for this type of activity. They also stated that the lab needs a

mechanism to do enhanced technology transfer as the federal budget shrinks and money gets tighter. Many laboratory managers recognize that the "lab" is changing and we've got to make an effort to identify potential external markets and applications. The process also needs to address the need for training to get people to think in terms of identifying potential technology and customers. Others felt that the process should emphasize collaborative efforts with industry and universities through consortia.

In addition to the more specific barriers identified in the previous section, the lab managers had some general thoughts on barriers. Most felt that cultural differences and the potential for apparent conflict of interest make technology transfer through exclusive cooperative R&D agreements difficult. As with most scientist and many engineers, recognition plays an important role in the motivation process. Therein lies another perceived problem in that some lab managers believe that the "cooperative" company may not give the lab credit for the technology transferred. Another barrier to effective transfer of technology from government labs is that everybody wants to transfer technology, but nobody wants to pay for it. The perception is that it's a good idea, but not so good an idea that the government is willing to fund the necessary staff and resources for conducting a dedicated and effective program. Finally, there is still a perceived barrier involving overclassification (national security wise) of some of the most promising technologies.

7.3 Laboratory research staff perspective

7.3.1 Main thoughts

The main thoughts laboratory staff has about working with commercial industry are reflected in the following paragraphs. This group represents nearly 30% of the total number of participants in the structured interviews and 43% of the total laboratory participants. The laboratory research staff obviously represents another one of the key groups of participants in the technology transfer process. For the purposes of this study, research staff was defined as scientists and engineers who are currently performing hands on activities or actually conducting R&D. This group is responsive to the leadership, direction and guidance provided by the laboratory management and federal sponsors. For the most part, this group represents the people who actually "do" technology transfer. Therefore, it is important to understand laboratory research staff's perspective on how they view commercial industry. This group of lab staff was asked the question "When you think of working with industry, what thoughts or images come to mind," where the term 'working with' was defined to be conducting some level of R&D activity. The following paragraphs summarize the key points identified by 20 laboratory research staff respondents from two large federal laboratories:

a. Contractors

Of all the lab research staff interviewed, 80% viewed industry as contractors. This is not a surprising result when you consider that one of the principal formal modes of interaction between industry and the federal

government (including the federal labs) is through the U.S. Federal procurement system. This system is governed by the Federal Acquisition Regulation and it covers all aspects of federal procurement through contracting.

Most laboratory staff members have, at one time or another, needed to acquire the equipment, services or supplies to accomplish their research which are readily available only through the commercial industrial sector. And, while the research staff may not be formally trained in the acquisition process, they will more than likely be familiar with the multiple forms, justifications and competitive source bidding required for anything costing more than a few hundred dollars. Hence, the commercial industrial sector is most frequently perceived to be represented as a contractor of some type.

The exact contractual nature of industry's interaction with the labs is fairly wide ranging. Industry can be viewed as contractors only or as salesman, company representatives, technicians or even highly qualified technical consultants. Some contractors are viewed as science shops whose personnel are not drilled in management techniques. Others are perceived to be contractors with quick reaction time on services which would be difficult to obtain internally. A number of lab researches recognized that while the labs may frequently do the science or technology conceptualization portion, they (the labs) turn to their commercial counterparts to provide the hardware product. Many laboratory staff members view industry as a structured, formal and expensive alternative to in-house R&D.

In addition to the inherent inconvenience of having to work through the

federal acquisition process to access industry, some researchers feel that industry operates from a profit driven perspective which often makes them reluctant to do things a different way. And of course, industry can portray just as much of a Not-Invented-Here (NIH) attitude as any other organization. This particular attitude though can cause great frustration when dealing with industry and make the interaction seem tedious and slow.

Finally, there is the perception amongst laboratory staff that sometimes industry doesn't absorb technology well. This perception was supported by a substantial number of the interview participants who noted the wide range and variety of industrial technical competency, and the high cost of acquiring satisfactory commercial support. Just as frequently however, the participants noted that this level of "contracting" often involved a significant amount of R&D and a comparable level of collaboration which distinguished it from a simple service or product purchased from a contractor.

b. Collaborators

Roughly 10% of the laboratory research staff interviewed perceived industry as collaborators on their R&D projects. This group generally believed that industry can move fast to do studies we can't and work with us to achieve critical portions of a research effort. This group also perceived the communication process as being important for these one-on-one collaborations.

c. Interaction unclear

Finally, the main thought of two out of twenty of the research staff

interviewed either hadn't worked at all with industry and didn't fully understand the concept of industrial interaction or they immediately cited barriers to effective interactions. Figure 7.3 summarizes the laboratory staffs' feelings and various awareness aspects of performing technology transfer activities or conducting cooperative research and development with a commercial entity.

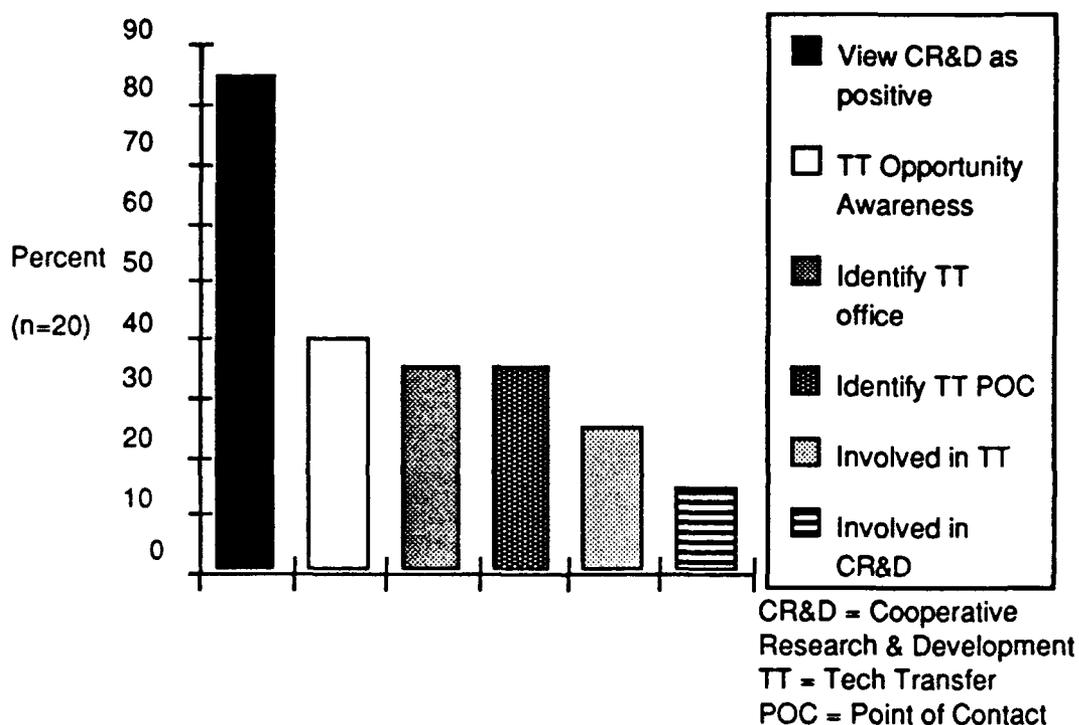


Figure 7.3: Laboratory Staff structured interview responses

7.3.2 Feelings about cooperative R&D

When the federal laboratory research staff interview participants were asked the second question of "How would you feel about conducting

cooperative research and development with industry?" their responses were consistent with those of lab management. Again, the term "cooperative research and development" was defined for each individual as a research process in which the lab would contribute personnel, equipment, facilities and direct lab funding of the internal effort, and the commercial partner would/could contribute personnel, equipment, facilities and/or funding to the laboratory to conduct R&D which is mutually beneficial to both the lab and the commercial entity. A clear majority of 85% indicated a positive or favorable response and many expressed visual or audible signs of real excitement. Only three of the twenty respondents were clearly uncertain and no one perceived it as negative.

7.3.3 Barriers perceived

Next, the federal laboratory staff were asked to answer the question of "What do you personally view as the top two or three barriers to conducting cooperative R&D?" Interestingly, this group's responses represented the greatest diversity of barriers perceived from any of the groups interviewed. Only one category, lab policy, represented any general consensus amongst the sample (20%). The remainder of the response categories reflected no more than six or seven percent per category. The following paragraphs represent a grouping of their responses by similarity of content:

a. Lab Policy

Twenty percent felt there was the lack of a clear and well publicized lab policy for conducting cooperative R&D. Lab policy - or lack thereof - represents

the largest single barrier to technology transfer from a laboratory researcher's perspective. The lack of a policy for guiding cooperative R&D efforts is demonstrated by the lab's perceived reluctance to seek out and communicate technology transfer opportunities to potential companies. For some researchers, this translates into inconsistent goals - since it is widely believed that the lab exists to do technology transfer. It was also believed that a major barrier, related to lab policy, deals with the unclear or misunderstood policy on ownership of intellectual property and the motivational effect this has on the expectations of lab employees.

b. Proprietary Limitations

Another perceived barrier to technology deals with the access and handling of industrial sector proprietary data and the necessity for free and open communication between the lab and commercial partner. Lab research staff perceive they frequently can't get enough details out of company to make for efficient communication of the really critical portions of the research activity. Lab researchers believe that industry is apprehensive about sharing data because of their (industry) perception that the government cannot control access or dissemination of the information.

c. Bureaucratic and legal roadblocks

Another perceived technology transfer barrier is the research staff's belief that the government doesn't really want the labs to participate in this activity because "government" is afraid somebody will make some money. This perceived bureaucratic roadblock combined with the belief that the barriers are

more legal than scientific tend to dampen the entrepreneurial technology transfer enthusiasm of many lab researchers.

d. Perceived conflict of interest

At the laboratory research staff level, there is a real concern over public perception. In many cases, top researchers sacrifice higher paying commercial sector jobs to perform research in a government laboratory. Many do this because of the greater flexibility associated with federal work, but most also feel a sense of contribution to the greater public good. As a result, the labs have developed a publicly perceived status of being impartial, unbiased and of the greatest integrity. Therefore, lab scientists and engineers don't want to compromise this position and look like their hiring out to industry. The reluctance to get involved with industry and thereby avoid the perceived conflict of interest is a powerful personal barrier to technology transfer.

e. Contractual barriers

The "red tape" perception of federal contracting is not a one sided affair. Just like industry's perception of working with federal labs, government lab researchers sometimes believe it is a pain to work with industry (e.g., contractual grief).

f. Miscellaneous barriers

Each of the following barriers represented approximately 3% of the responses from the laboratory research staff interviews

- Government sponsor's concurrence
- Not a realistic way of doing business (via CRDAs)

- Difficulty in finding civilian match (partner for CRDAs)
- Concern that industry is just after a future government contract
- Don't see it happening (extensive cooperative research - sharing of responsibility and authority), lab people want to do hands on work
- Security, critical technologies issues
- Risking career, not a top priority with management
- Difficulty in meeting deadlines for scientific reports
- Perceived bulk of advantages are for the corporation
- Industry doesn't understand relationships and opportunities

7.3.4 Opportunity awareness

The fourth question posed to the laboratory research staff representatives was "Are you aware of any recent opportunities and/or guidelines concerning cooperative R&D or technology transfer from the federal laboratories to the private commercial sector?" Only eight out of twenty or just 40% indicated some level of awareness of recent technology transfer opportunities as a result of internal policy, procedures/guidelines or federal legislation. As with those surveyed from commercial and laboratory management participants, the level of awareness varied considerably but was not specifically quantified as part of this research.

A follow-up question, posed to those research staff representatives was if

they knew who to contact, within their own organizations, for additional information and/or help in conducting such (technology transfer or cooperative R&D) activities. Only 35% of the lab staff interviewed were able to correctly identify the organization's designated technology transfer office and name the organizational point-of-contact (POC). A major distinction between the laboratory staff and lab management is that 65% of the staff indicated that they did not specifically know who to contact for more information and were unable to provide an office or individuals name as a technology transfer POC. Whereas only 30% of the lab managers did not specifically know which office or person to contact.

7.3.5 Involvement

To discern the level of laboratory research staff involvement in either technology transfer or cooperative research and development activities, the interviewees were asked "Are you now, or have you been involved in either a technology transfer or a cooperative R&D effort with a commercial company?" Five out of 20 or only 25% of the respondents indicated that they either were or had personally been involved in a technology transfer from a U.S. federal lab to the commercial sector (this included transfers to commercial sector DoD contractors). Only 15%, however, indicated that they had actually participated in a cooperative research and development (formally or informally) with a commercial company. In addition, the data collected indicated that 60% of the laboratory staff respondents had not participated in either a technology transfer

activity or any form of cooperative R&D with a commercial industrial company.

7.3.6 General comments

There were three main categories of general comments provided by the laboratory research staff participants in addition to a number of unique thoughts. The three main categories dealt with awareness, difficulty of interaction and the potential stimulation from external interaction. Each of these is described in more detail as follows:

a. Awareness

Awareness is a problem. The laboratory management must do something to address this internal need. One suggestion offered by a respondent was to conduct internal awareness meetings. Awareness, however, is also an issue requiring external measures. One interview participant went so far as to say that they felt that getting the word out to industry (through marketing) is the key to a successful technology transfer program. Another participant suggested we (the labs) use existing tools such as the Commerce Business Daily (CBD) announcements to alert industry to laboratory research opportunities.

b. Interaction Difficulty

As one research staff member stated, "the biggest problem is wariness on both sides." This wariness is caused by a long history of perceived - if not real - constraints and questions of utility of interacting with the other party. In addition, as federal budgets get tighter in the coming years, laboratories will begin to view the "competing" research ideas and projects in industry as a potential

problem for securing the limited federal research funding. This type of wariness and competition strains the existing relationships and may make the establishment of new cooperative relationships difficult.

c. Stimulation

Some of the research staff recognize that in the commercial sector there are a lot of potential business opportunities which many in the labs may find interesting and stimulating as a change-of-pace. One laboratory researcher noted that "even though the cooperative effort I participated in was the most frustrating, it was also the happiest and most rewarding part of my career."

d. Miscellaneous comments

"If we (federal labs) are to survive, we need to do this DT2 (domestic technology transfer)." This was the sentiment echoed by one laboratory research staff member. Although it may seem a bit extreme, the serious nature of this activity is certainly highlighted by this individuals comment. It makes one wonder to what extent does the "survival" of the United States Federal Laboratory System depend upon a successful implementation of enhanced technology transfer practices and interaction with commercial industry.

Still other thoughts about laboratory-commercial sector interaction noted that in many cases the nature of federal laboratory research is unique and it would therefore be hard to find a company doing same sort of work. Without a comparable need or qualified group of individuals to transfer the technology to in the commercial sector, there would be no hope of extending the utilization of federally funded technology beyond the walls of federal laboratories.

As a final thought, seven of the twenty laboratory research staff participants were asked whether or not their job descriptions contained any reference to domestic technology transfer activities or technology transfer to the public or private sector. Of those asked, 100% indicated that there was no such reference in their job descriptions and the subject never came up during any job performance evaluations or promotion considerations.

7.4 Legal counsel perspective

While the sample of legal counsellors interviewed was relatively small (only 4 out of 67 or 6% of the total number interviewed), their responses were consistent and unanimous regardless of whether they were from the government or commercial sector. Figure 7.4 summarizes the legal counsels' feelings and various awareness aspects of coordinating technology transfer activities or negotiating cooperative research and development agreements with a commercial entity.

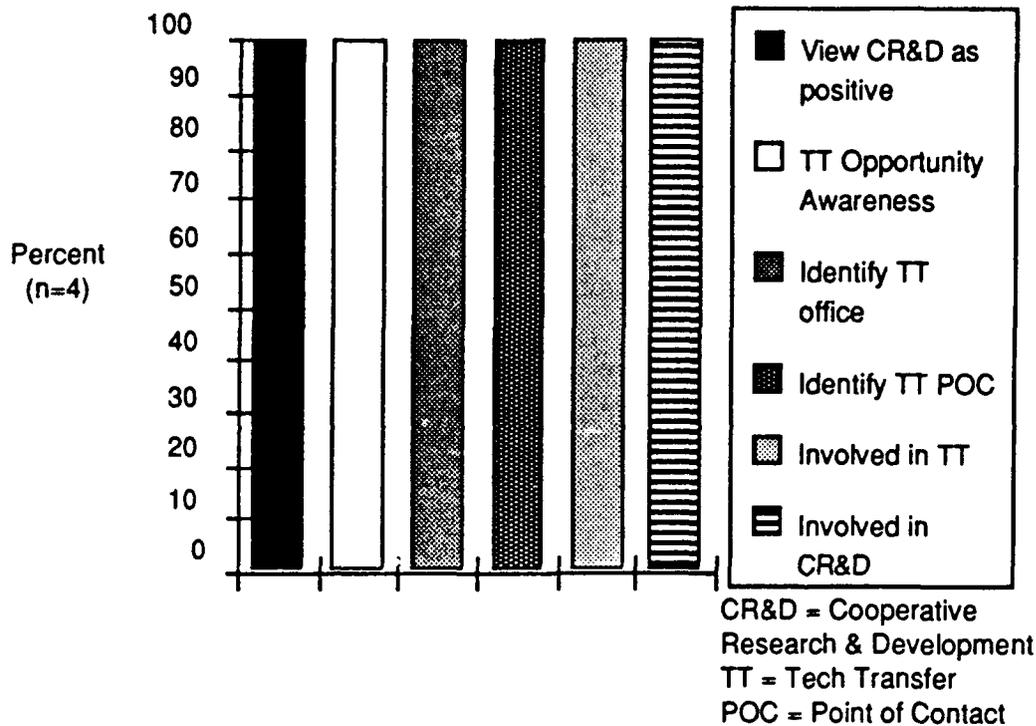


Figure 7.4: Legal Counsel structured interview responses

7.4.1 Main thoughts

The main thoughts presented by the legal counsellors (subsequently referred to as lawyers) were grouped into three areas: skepticism; response time; and, contracting. Each of these is described as follows:

a. Skepticism

If government labs and commercial industry are to work together on a cooperative basis, then both sides will have to work to overcome the skepticism about working with the other. This will involve breaking down historical barriers and **working hard to understand each others perspective.**

b. Response time

Industry is used to responding to much shorter R&D and manufacturing cycles in order to remain competitive and maintain a profitable business concern. On the other hand, federal labs are only now experimenting with ways to really expedite the R&D process and for certain phases of a cooperative effort may find it difficult to respond as quickly as industry wants and/or needs. These differences in response time to the users needs will have to be recognized and planned for - especially for any initial or preliminary cooperative efforts - to avoid misconceptions or the development of unreasonable expectations.

c. Procurement contracts

Since nearly all formal commercial sector-federal laboratory interaction has been in the form of procurement contracts, a certain culture and mind-set has developed to deal with this type of working relationship. But, just as the best companies in the world are recognizing the importance of establishing cooperative long-term working relationships (sometimes even with competitors) U.S. industry and federal labs must also recognize the importance of developing new cooperative relationships. The federal laws and practices associated with the U.S. federal procurement process are not applicable to this new working relationship. Confusion associated with this "historical working relationship" of procurement contracts acts as a major impediment to achieving the goals and objectives of the new U.S. federal legislation and agency regulations.

7.4.2 Feelings about CRDA efforts

Of the four attorneys interviewed, three were government employees and one was from a commercial industrial company. When asked how each felt about conducting cooperative R&D with the respective commercial or federal partner, 100% indicated a very positive response.

7.4.3 Barriers perceived

Among the government and corporate lawyers or technology legal counsel there were three main barriers identified: awareness; ownership/protection of intellectual property rights; and, micromanagement from higher headquarters. Each of these barriers is described in more detail as follows:

a. Awareness

The key awareness issues identified included the general level of awareness of technology transfer opportunities within the labs; the awareness within the labs of which companies to go to with proposals for cooperative R&D; and, the industrial corporate awareness of technologies, facilities and research professionals within the federal labs.

b. Intellectual property rights

There are two principal barriers associated with intellectual property rights. First, as pointed out by a government lawyers, much of the R&D conducted by federal laboratories has been contracted out over the years. As a result of this extensive contracting activity, there is some question as to government ownership of these "contractually obtained" technologies. A second major

concern voiced by the commercial sector is the government's perceived inability to protect the intellectual property either brought to or created by parties during a cooperative R&D effort.

c. Headquarters Micromanagement

Finally, the unanimous consensus amongst the government legal counsel which coordinates these cooperative agreements is that there is too much micromanagement of the cooperative research and development agreement (CRDA) process from higher headquarters. Under current agency regulations, the responsibility and authority for developing a CRDA has been delegated to the laboratory director (or military commander) in charge of a research facility. However, higher headquarters (HQ) has maintained review rights. Currently, there is a 30 day review period after the CRDA has been coordinated and signed by the lab director and commercial partner. Unfortunately, there is also the perception that HQ is too slow in their response and that they should delegate this review authority to lower levels - perhaps to a comparable authority within the labs themselves.

7.4.4 Opportunity awareness

The fourth question posed to the lawyers and legal counsel representatives was "Are you aware of any recent opportunities and/or guidelines concerning cooperative R&D or technology transfer from the federal laboratories to the private commercial sector?" One hundred percent indicated an awareness of recent technology transfer opportunities as a result of internal

policy, procedures/guidelines or federal legislation. Within this group there was a more consistent level of awareness and this was expected due to the nature of their work.

A follow-up question, was if they knew who to contact, within their own organizations, for additional information and/or help in conducting such (technology transfer or cooperative R&D) activities. Again, all four were able to correctly identify the organization's designated technology transfer office and name the organizational point-of-contact (POC).

7.4.5 Involvement

When asked whether or not each had been involved in a technology transfer or a cooperative R&D coordination effort, all four participants responded affirmatively. Each individual had represented their organizations in the process of negotiating the technology transfer and cooperative R&D agreements.

7.4.6 General comments

When asked about final general comments about technology transfer or cooperative R&D, there were three main ideas expressed. First, the problem with government ownership of technology and problems concerning copyrights was noted. Second, the need for a major public relations program to get the word out to both the laboratory management and staff, and the commercial sector was highlighted. Finally there was the notion that the CRDAs currently

represent "the most important alternative to a procurement contract" for laboratory-industry interactions.

7.5 Technology transfer specialists perspective

The sample of eight technology transfer specialists is comprised of individuals within or closely aligned with the federal laboratory system whose principle responsibility is to work with the laboratory management and research staff, and the commercial industrial sector to perform technology transfer. Technology transfer specialists interviewed for this research included representatives from the three different types of federal laboratories which include: government owned government operated (GOGO) laboratories; government owned contractor operated (GOCO) labs; and, federal contract research centers (FCRCs) which are also sometimes referred to as federally funded research and development centers (FFRDCs). In addition, this sample includes a federal employee currently assigned to a unique nonprofit organization whose mission is to facilitate technology transfer from federal laboratories to the commercial sector for the purpose of commercialization.

This sample group is most responsible for coordinating and negotiating all of the various details between the technology transfer principal parties. These individuals typically contact or are contacted by the research staff member which begins a negotiation process. This process eventually expands to include negotiations with internal laboratory branch, group and division

management; the laboratory director or commander; the patent attorney(s) or legal counsel; the external commercial industrial technical partner and their management; and higher (government agency) headquarters. This negotiations process is critical and can in fact be defined as "the technology transfer process." This process will be more clearly defined in a subsequent section of this thesis.

7.5.1 Main thoughts

The initiatives demonstrated by this group are fundamental to accomplishing an effective and efficient technology transfer program. Therefore, the main thoughts and perspectives of this group should be analyzed very closely and carefully. Since this group plays the central role in coordinating and facilitating the entire technology transfer process, the main thoughts of each participant have not been consolidated, but rather are represented individually so as to gain the most potential insight from their comments. Their main thoughts are as follows:

a. Need to dispel industry-government adversarial relationship

Technology transfer specialists need to work within the laboratories and through external activities to dispel notion that the government and industry are adversaries. This perception has developed over many years of government contracting with the commercial sector, but it is not applicable to the new technology transfer mechanisms and techniques such as the CRDA.

b. Need to enhance the marketing of lab technology

Personal experiences indicate that at the present time, industry is receptive to working cooperatively with federal labs, but a greater marketing of laboratory technology is needed.

c. Need to address cultural differences

Federal laboratories and commercial entities are perceived to have vastly different organizational cultures. All parties involved need to recognize these potential differences, but refocus on addressing why a cooperative arrangement can work due to these varied (but perhaps complementary) differences.

d. Need to expand nonprofit initiatives

Nonprofit initiatives are needed to enhance technology transfer. At the present time nonprofit initiatives offer an opportunity for expanding federal technology transfer activities by coordinating public/private joint R&D ventures which share the risks and rewards and help both commercial entities and government laboratories cope with ever tighter R&D budget constraints.

(Reference: American Technology Initiative Corporation, ph. 415-325-5494)

e. Need to recognize industry's profit motive

While the government labs are frequently involved in earlier phase research activities which are longer range with broader potential applications, industry is most commonly focused on specific technology and their driving force is the profit motive. Simply recognizing this can help technology transfer specialists target laboratory projects and technologies which fit the more common industrial pattern, or help them find private companies with longer

range goals which match more closely with the necessary long term goals of the federal labs.

f. Need for better guidance

Technology transfer through cooperative research and development is a good idea, but it's not well enough understood. Although the legislation for enhanced technology transfer has been in existence since 1986, legislated technology transfer is not technology transfer. Only now are the federal laboratories and commercial companies beginning to appreciate the full potential of these cooperative arrangements. Since 1988, when there were reportedly only about 100 such agreements in existence nationwide for all of the roughly 700 federal labs, the number negotiated has essentially doubled each year. By 1989 there were approximately 200 and by 1990 there were reportedly around 400. The trend is promising, but specialists (and other lab personnel) indicate one of the reasons for the slow start is insufficient or nonexistent policies or guidelines.

g. Need to expand efforts to include industry and universities

With renewed industrial interest in working with universities, tremendous potential exists for strengthening the involvement of universities, federal labs and industry performing cooperative, precompetitive R&D.

h. Need to gain experience in the cooperative R&D process

By simply taking the total number of CRDAs and dividing by the number of federal laboratories as of 1990, the average is about one half CRDA per lab. Some labs have dozens of CRDAs signed and dozens more in negotiation.

Other labs still have yet to sign their first formal CRDA. The reasons for this are varied and range from laboratories perceiving their R&D as non-commercializable to justifiable concerns over previous legal interpretations and only recently getting legal approval to do significant work with industry. Consequently, there is still very little experience to draw upon within any given laboratory when planning or negotiating a CRDA.

i. Other issues which were identified by many of the participants in response to this question included concerns over unfair technology transfer and equal opportunity of access to lab technologies; the uncertainty associated with the lingering antitrust issues; and, the perceived lack of Congressional reliability in consistently addressing technology transfer goals, objectives and support. Figure 7.5 summarizes the technology transfer specialist's feelings and various awareness aspects of performing technology transfer activities or negotiating cooperative research and development agreements with a commercial entity.

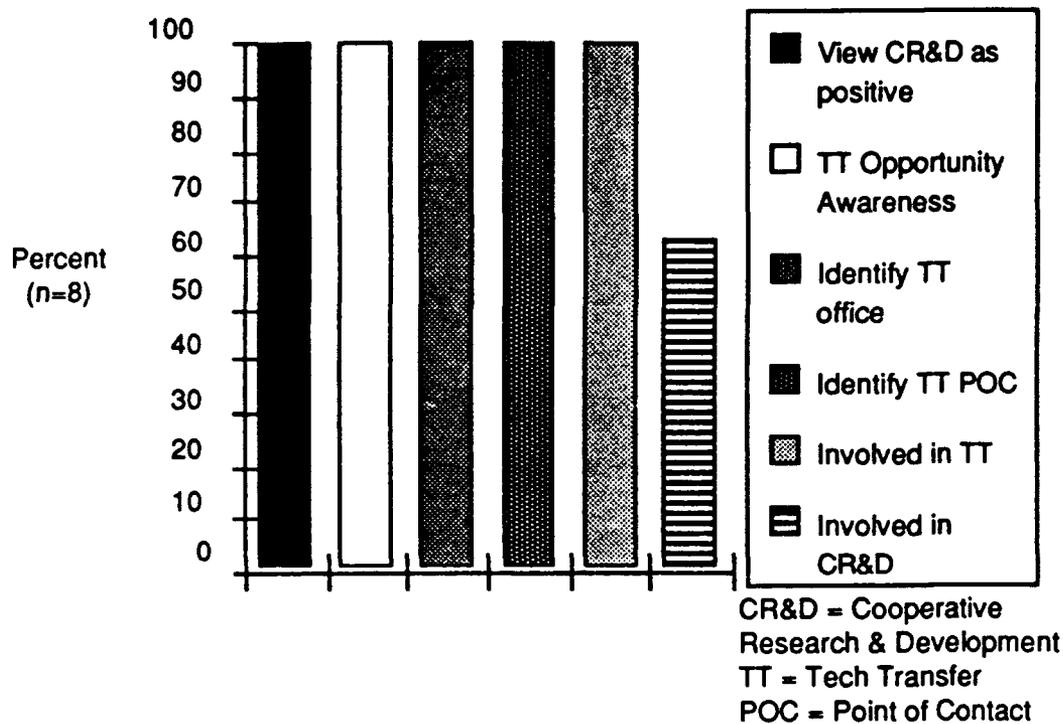


Figure 7.5: Technology Transfer Specialist's structured interview responses

7.5.2 Feelings about CRDAs

When the technology transfer specialists were asked how they feel about conducting cooperative R&D with industry, it was not surprising that all eight or 100% responded positively and enthusiastically. All individuals were familiar with the term "cooperative research and development" which was defined for each individual as part of this research process and to ensure a common understanding and definition of terminology.

7.5.3 Barriers perceived

The following paragraphs represent a summary of the key barriers

perceived by technology transfer specialists:

a. Legal issues

Of all the barriers identified by technology transfer specialists, 26% were legal barriers. There are a multitude of perceived legal issues which form a barrier to pursuing cooperative work with industry. Previously, the labs did not have legal authority to conduct this type of cooperative work and although they do now, it is still perceived by many that the opportunity doesn't even exist.

Recall that only 40% of the lab staff and only 74% of lab managers interviewed were aware of these opportunities. There are also the legal issues concerning negotiations problems

concern over intellectual property rights

need to develop a group of standard alternative clauses for CRDAs

b. Cultural differences in perspective

Twenty-one percent of the technology transfer specialists cited cultural differences as a major barrier. There are a major differences in the points-of-view which range from government-industry interactions focused on procurement and buying to seeing the federal labs as facilitators and conduits for technical knowledge. Industry is perceived as thinking that the labs have no "business sense" and that to work with the labs involves a lot of government red tape. To make this type of technology transfer work, a cultural change is needed.

c. Motivation

Technology transfer specialist's cited motivational barriers in 21% of their

responses. They noted the need for incentives to motivate the lab staff and for some additional type of reward or recognition system. They also noted that in general middle management is not convinced of the need to do technology transfer to the commercial sector and is not motivated to do it. Their performance is not measured by their technology transfer activities, but rather by how well they meet their sponsor's requirements within the budgetary and administrative constraints.

d. Transfer mechanisms and models

Sixteen percent of specialist's responses focused on inadequate mechanisms or models. They also noted that "CRDAs don't always lead to tech transfer." This is an important observation for those considering ways to measure technology transfer performance - you can't simply count the CRDAs. And, while it was noted that all CRDAs are unique and all have special requirements which makes standardizing CRDAs difficult, there is a need for a consistent model agreement to expedite the CRDA development process and reduce analysis time. As a note to this point, at least one technology transfer specialist is in the process of having their legal counsellors draft multiple clauses which would all be preapproved and could be essentially "cut and pasted" into the agreement depending on the circumstances. This would achieve at least part of standardizing certain elements of the CRDA and thereby reduce analysis time for that section.

e. Awareness

Surprisingly, only 11% of the technology transfer specialists responses

identified awareness as a major barrier to technology transfer. The aspects of awareness identified as principal barriers included finding the specific match, or industrial partner which fit the laboratory's research project and a general lack of awareness of opportunities throughout the labs and industry. As part of the analysis of these results, it should be noted that while awareness is 100% within this particular segment sample, the laboratory staff and management demonstrated a significantly lower level of awareness. Therefore, addressing the awareness barrier perhaps should be more of a priority for technology transfer specialists in the future.

7.5.4 Opportunity awareness

As technology transfer specialists, whose job it is to coordinate applicable technology transfer activities within a laboratory, it is not surprising to see that fully 100% are aware of the associated opportunities, offices and individual points of contact.

7.5.5 Involvement

The data collected indicates that 86% of the technology transfer specialists sampled are or have been involved in an actual transfer of technology from the lab to the commercial sector. Sixty-three percent either are or have coordinated a CRDA and 75% are able to recall the specific commercial partner(s) who participated in the CRDA.

7.5.6 General comments

Some of the general comments noted by the technology transfer specialists are observations and some are recommendations.

a. Observations:

- We are dealing with differing priorities of the lab and industry
- The federal labs still have a big job to do concerning awareness
- The proper integration of a technology transfer program will result in an advantage to R&D from the interaction of government and industry
- Some specialists are part time or temporary positions - it may be hard to find the right person to talk to

b. Recommendations:

- Each lab needs a multidisciplinary team composed of the specialist, the legal advisors and the technical staff and managers
- There is a distinction between patent attorney and contract attorney which has an impact on how CRDAs are negotiated
- The labs need the kind of negotiating flexibility which now exists at the universities

7.6 Economist's perspective

7.6.1 Main thoughts of a Nobel Laureate

When Dr. Robert M. Solow, a famous international economist at M.I.T., was asked "When you think of working with federal laboratories, what thoughts or images come to mind?" the response was "I have no personal experience in working with the labs, so my opinion is mostly second hand." With this qualification, the economist went on to identify three important observations.

First, it was noted that "if the national labs are to provide useful technology to industry or a group of firms, then the labs need to establish a long term relationship with industry. The current problem is the notion that the technology can just be handed off." Dr. Solow's second point was that, "Within large corporations, with large R&D efforts, the best way to transfer technology is to transfer people. It would be interesting," Dr. Solow thought, "to find a way where people from the federal labs could be transferred to the private companies to transfer the technology." *It was also noted that,* "One problem with this would be that if the people transferred were good (technically speaking), then they would probably be bought away from the labs." And, a further observation was that, "That might not be so bad. It might actually be a good way to transfer technology."

Finally, the Dr. Solow noted that on the macroeconomic level, "the problem of more effectively utilizing the federal labs and finding a way for industry to profit from the laboratory technologies is just an extended version of the problem of how to get U.S. firms to expedite the application of technology."

7.6.2 Feelings about cooperative R&D

In general, the economist's feelings about such cooperative efforts between government and industry are positive. However, there was some concern about the fairness of allowing a single or a few companies capitalize on the technologies invested in by the American public. The question raised is whether or not the federal laboratories should be used in that way.

7.6.3 Barriers perceived

When asked about the perceived barriers to conducting cooperative R&D between federal labs and industry, the Dr. Solow identified four main areas. They are as follows:

- a. Conflict of Interest issues. There are problems (documented) which indicate that the government has yet to publish guidelines which address this major issue.
- b. There are Freedom of Information Act concerns about the availability of information developed in a federal laboratory and how this will be impacted by the cooperative agreements and necessary protection of mutually developed technology and proprietary data concerns.
- c. There is the seeming inability to establish a long term relationship between labs and industry based upon the historical contractual working relationships.
- d. Finally, many believe lab technology should be available to all U.S. industry. There may be some industry concerns of improper laboratory use.

7.6.4 General comments

In his closing comments, the Dr. Solow had some interesting observations which included the following remarks:

a. "U.S. Department of Defense funding of R&D is probably a drag on the capacity of U.S. industry to compete in a world market. The amount of spin-off (which was perceived to be greater during the 1950s and 1960s) has diminished over time. Instances like the jet and the early computer are fewer."

b. "The remarkable research enterprise of federal laboratories has made those companies which participated in the process unfit for survival in a commercial market. Years of a single customer (i.e., DoD) with deep pockets will force industry to have to unlearn it all. It's important for a way to be found to educate the defense industry in what it's like to live in an open market."

c. "The federal labs could have a tremendous impact (on helping the U.S. economy), but they need to better understand the demand side in industry."

8. CRDA NEGOTIATION PROCESS

By definition, a CRDA is "Any agreement between one or more Federal laboratories and one or more non-Federal parties under which the Government, through its laboratories, provides personnel, services, facilities, equipment, or other resources with or without reimbursement (but not funds to non-Federal parties); and the non-Federal parties provide funds, personnel, services, facilities, equipment, or other resources toward the conduct of specified research or development efforts that are consistent with the missions of the laboratory; except that such term does not include a procurement contract ... and as such the Federal Acquisition Regulation (FAR) and the DoD FAR Supplement are not applicable to these agreements." (DoD Reg.3200.12-R4, p.iv) This definition is reiterated here as a reminder that although many of the concepts, issues and barriers associated with technology transfer are pertinent to many different organizational environments, this thesis research was conducted with the above definition in mind. The definition was also used to help identify the key participants and to provide a focus for addressing "how to" reach a cooperative agreement for conducting specified research or development consistent with both the missions of the laboratory and the objectives of the commercial corporation. This section identifies the "how to" aspect of achieving a cooperative research and development as being one of negotiation. It is only through a persuasive, believable and credible negotiation process that such agreements are hammered out; and only through such agreements that the United States can begin to effectively utilize federally

funded research and development in the private commercial sector. Therefore, to enhance our capitalize upon the considerable U.S. federal investment in R&D, there must be a more complete understanding of the CRDA negotiation process.

In order to thoroughly understand and document the CRDA negotiation process, two CRDA examples were evaluated in detail. Follow-up interviews were conducted with representatives from the commercial industrial sector and the federal laboratories to discern the various steps and phases of the process. From these in-depth interviews a flow-chart of the steps was prepared; verified through additional interviews for accuracy, and; analyzed to identify logical flow and critical phases of the process. Based upon these detailed interviews, three phases of the CRDA negotiation process were clearly identified. These phases are the initial contact phase; coordination and negotiation phase; and the review and approval phase. Each of these phases are described in detail in the following section which steps through a CRDA example.

8.1 Initial Contact Phase

During this phase of the CRDA development process the principal cooperative parties meet. The two main ways in which this contact can take place are for either the laboratory scientist, engineer or representative to contact the commercial sector counterpart, or vice versa.

For the generic case where the contact is initiated from the federal laboratory representative, the sequence of events goes something like this:

- a. Lab research staff member recognizes a potential alternative application and notifies his/her immediate lab manager.
- b. The lab manager then notifies the laboratory technology transfer specialist (called an ORTA at most federal labs) of the CRDA opportunity.
- c. The ORTA meets with the staff member and lab manager for initial consideration of the technology and to provide some explanation about the CRDA process.
- d. The ORTA contacts the government agency patent counsel and sets up meetings to introduce the lab technology people to the agency legal people to address the questions of invention disclosure, patent opportunities and cooperative research and development agreements (CRDAs). If the attorney believes there's a CRDA opportunity, i.e., the subject technology is government owned technology not related to an existing procurement contract, then the appropriate legal actions are taken to protect the technology and the laboratory staff member is advised to find a cooperative partner for further technology exploitation. Note: It is currently not specified how a staff member is to find a cooperative company. Some labs advertise in the Commerce Business Daily; others are sufficiently aware of their commercial counterparts to know exactly who would be qualified and interested in pursuing a cooperative effort; still others "advertise" by word of mouth, unofficial forums or venture capital group meetings. The method of advertising is becoming increasingly important as laboratories struggle to overcome the technology transfer barrier of providing equal opportunity or access. Increased emphasis on advertising through

technology fairs or conferences, perhaps organized by the Federal Laboratory Consortium or the Technology Transfer Society, appears to be something that is needed.

For the generic initial contact case where the commercial industrial sector representative initiates the contact, the individual typically has some awareness of the opportunities associated with the new technology transfer legislation or ability to access federal laboratory technology. In both of the examples researched for this thesis, the commercial sector representative contacted the federal laboratory first.

In one case, the commercial representative was the president of a small company who had read about the 1986 Federal Technology Transfer Act and directly contacted the federal lab scientist who was known (through previous associations with the lab) to be responsible for the particular technology in question. In a second example, the laboratory staff member was also contacted directly by the commercial representative (a university professor interested in commercializing a modified lab technology through a third party manufacturer) who had "picked up" on CRDAs as a buzz word and didn't really understand the details - but, understood enough to recognize the commercial opportunity.

These two examples, which will be used throughout the remainder of this section on the CRDA process, contain such similar characteristics that they will simply be addressed as a single composite example for discussions about the coordination and negotiation process section and also for the review and approval section. It should also be noted that although the next section is

labeled as the negotiation process section, a considerable amount of negotiation has potentially already taken place to get to this point of initial contact.

If the initial contact phase is initiated from within the federal laboratory, the negotiations started with the first words spoken between the principal research staff member and the technology transfer specialist. If you view the negotiation process as not only trying to "sell an idea, but also trying to persuade someone to adopt our viewpoint, " as noted by Bob Woolf in his negotiations book entitled Friendly Persuasion (p.28), then you can appreciate the negotiation implications of this from these first interactions. Whether the staff member contacts the ORTA or the ORTA recognizes the commercial potential of a certain technology and calls upon the staff member, the initiator will be trying to convince the other to "see" his/her viewpoint and share the enthusiasm. An ineffective negotiation at this point could delay or negate subsequent interactions to discuss further details. For instance, if the staff member is not able to help the ORTA recognize that a viable commercial application exists, the process might go no further. As an observation, at the present time, this is more likely to be as a result of the ORTA workload and prioritization and not necessarily due to disinterest or lack of a shared viewpoint with the lab staff member. Understanding what motivates both the lab staff member and the ORTA, to want to accomplish technology transfer, is an important factor in a successful negotiation.

Additional negotiations take place within the government lab as the ORTA

and staff member interact with higher lab management. Shared viewpoints concerning available technological and legal opportunities are critical to continued success. The ability of the laboratory team (staff, manager and ORTA) to effectively negotiate with the government legal counsel is also a critical step regardless of whether this interaction takes place prior to the initial commercial contact or through post-contact meetings to ensure sufficient protection of the intellectual property rights. Please note that these early phase legal counsel meetings differ dramatically from the review and approval phase meetings which are more focused on adequacy and sufficiency of the wording of the agreement from a "contractual" perspective.

This brings the process back up to the point where either the commercial and government parties are either searching for or attempting to establish the initial contact with the other party. Here again, this may be something as simple and straight forward as one individual calling another to introduce the perceived opportunity and discuss the potential; or, it could be a rather long and involved process which entails tracking down the appropriate government/commercial representative for the subject technology. For this research it was just coincidental that the examples chosen were both initiated by the commercial sector and were both direct contacts. While it is envisioned that the alternative method of having to track down the appropriate counterpart would be a more challenging task, this research did not pursue that specific aspect and therefore does not address further details of that approach. However, the research clearly indicates that even with a direct contact, the

negotiations required to ensure continued interactions and strive towards an agreement are by no means trivial. In one case, the government scientist could not see the point and wasn't impressed with the proposed cooperative effort and commercialization. This particular case required a significantly greater effort to persuade the essential government counterpart to see the viewpoint of the commercial representative than did the other CRDA where the government scientist seemed more interested and cooperative from the initial contact. Note that this may have had something to do with the time lag between these two different efforts of approximately three years, i.e., additional awareness and education about the technology transfer opportunities occurred during this period. Here again, motivation is a factor in this interactive process. For either the government scientist or the commercial representative to be interested in participating in a cooperative R&D arrangement, they have to be convinced that the process will be profitable for them and/or their organizations, or that there will be some realizable gain or benefit.

8.2 Coordination and Negotiation Phase

Once the initial contact has been made, the process enters into the critical phase of coordination and negotiation. In the examples researched, they both contained the structural characteristics as identified as follows:

- a. Initiation of an iterative process involving the principal technical person for each party, the lab technology transfer specialist or ORTA, and other commercial technical/marketing people as required to thoroughly understand

the technology exploitation potential. This includes the discussion of all the technical aspects as well as the preliminary acknowledgement of and verbal agreement to the essential agreement obligations.

Although it was not clear from the research to what extent it happened, it should be noted that during this phase it is important for the negotiators to probe beneath the surface of their counterpart's "position" to discover underlying needs, as noted in the book Negotiation, by Lewicki and Litterer (p. 109). This technique can allow each participant, through a better understanding and restatement of the perceived requirements, to determine and satisfy the other's latent needs. An inadequate understanding of these needs, by either party, can drive the negotiations down a wrong path towards an inadequate solution.

One observation made during these detailed interviews that has implications for both (or all) parties involved in a cooperative R&D negotiation is that it is important for each organization to form a negotiation team to meet formally before arranging any outside meetings. This is to ensure that each party has considered the important aspects of the negotiation from their own perspectives and to try to view the potential agreement from the other party's perspective as well. This does not require formulating a hard and fast position; but rather having thought through the preferred outcomes and having identified a number of potential objectives. Additional objectives, which have a mutually beneficial outcome, may materialize after meetings with the potential cooperative partners.

b. Input and guidance from the government legal counsel concerning appropriate intellectual property considerations and cooperative agreement (document) clauses for preliminary drafting of the written agreement. Expert legal counsel, typically from experienced patent attorneys, provides a key service during these early phase negotiations. Although some of the technical staff interviewed believe that legal counsel involvement should be minimized during the earliest phases while the focus is on how to achieve mutually beneficial technical objectives, the fact remains that legal's role in the process can not only help shape reasonable expectations, but also preclude downstream hard feelings or ineffective working relationships due to misunderstandings about intellectual property clauses.

c. Drafting of the CRDA from meeting notes and/or existing models. This process starts by having the government technical participant define in a few pages what is to be transferred from/to the laboratory; who is involved in the cooperative R&D process (key participants and positions); and how much/many resources will be involved (including human resources, equipment, facilities, and funds). By the time this segment of the phase is reached, most of the technical details have been negotiated and verbally agreed to by the key technical participants. The remainder of this phase formalizes the verbal arrangements.

Negotiations during this segment are conducted informally between the laboratory technical staff member who is drafting the agreement and his/her corporate counterpart who is consulted to verify and/or confirm the "understood"

conditions of the verbal agreements. In addition, negotiations may continue between the federal lab staff member and his/her manager (branch, group or division leader) to ensure management's commitment to the cooperative project. The impact which management can have on the process should not be overlooked. This thought was documented during individual thesis interviews and during the detailed follow-up interviews. The same thought was highlighted by Alan Schriesheim in his article entitled "Toward a Golden Age for Technology Transfer" in the journal Issues in Science and Technology (Winter 1990-91, p. 55) where he notes that "Negotiations proceed more quickly when top management knows about them and supports them. Thus any information campaign should target people with the authority to sign-off on the results of negotiations." This same topic of "signing-off" represents the next logical phase which was apparent from the analysis of the logical flow of the CRDA negotiation process and is discussed in the next section.

8.3 Review and Approval Phase

After the laboratory staff member has drafted the CRDA, with the help of his/her outline, input from the ORTA and legal, and perhaps format or content recommendations from a model agreement, the formal review and approval process and "signing-off" can begin. The review and approval steps identified during thesis research interviews were as follows:

- a. Typically, based upon some model agreement provided by the ORTA to the staff member, the lab staff member would prepare an initial "draft CRDA."

This draft CRDA would be a marked-up or edited model agreement made to correspond with the previously negotiated details.

b. Copies of the marked-up "draft CRDA" would be provided to the ORTA and the government legal counsel in parallel. (Recall, at this point, the government legal counsel is only looking at the document from an intellectual property protection point-of-view.)

c. The ORTA consolidates comments about the draft CRDA which may include information concerning patent and/or licensing clauses, exclusive rights clarification clauses, and explicit statements about what the federal laboratory or government will receive from the arrangement.

d. Then, the ORTA returns the draft CRDA with the consolidated comments to the principal lab staff member and requests an update and feedback on the comments.

e. Follow-up meetings are scheduled between the lab and the legal counsel to address modifications and corrections.

f. A formal Draft CRDA is prepared and distributed to the lab's sponsoring agency headquarters (who subsequently has their own legal counsel review the CRDA from a contractual perspective); the commercial industrial company, and; the local agency and headquarters legal counsel. Each of these participants reviews the Draft CRDA in parallel and questions or clarifications are typically worked out through telephone coordination. The headquarters organization has no more than 30 days to review and approve or disapprove the agreement.

g. If no negative comments or feedback is received from headquarters, the ORTA prepares a staff summary sheet to have each of the principal government participants sign their concurrence on the agreement. This typically includes the laboratory staff member and division manager; the lab director of plans and programs; the laboratory director or commander; the agency's local and headquarters judge advocate or legal counsel, and finally; the agency commander or designated headquarters representative. In addition, the commercial corporation usually has a representative sign the staff summary sheet to acknowledge having reviewed the final document; and both the corporate and government representatives sign the actual CRDA to formalize their commitment to the cooperative effort.

8.4 Summary of CRDA negotiation process

While the above discussion represents the process associated with only two examples of CRDAs, the interactions of the various participants are believed to be representative of the more generic process required for the development of most cooperative agreements. And, while it may be difficult to develop a specific model for all CRDAs, due to the unique nature of each agreement, the three phase model empirically developed does seem to group the information flow and activities sufficiently to allow for the formulation of a negotiation strategy. The model developed from the observations and analysis of these agreement negotiations includes the initial contact phase, coordination and negotiation phase, and the review and approval phase. Any strategy

developed to enhance the CRDA negotiation process should recognize these phases and address the following points as revealed from these studies:

a. Know what your objectives are. Document what they are and what you are willing or able to contribute towards achieving them. Use this information to help prepare with your initial internal contacts. Whether you're the research staff, the manager, or the technology transfer specialist advance preparation will help make your initial discussions more believable and convincing.

b. Organize a team consisting of the staff scientist or engineer, the technology transfer specialist and the legal counsel to prepare for the negotiations - prior to the initial contact if possible.

c. Find out what your potential partner's strengths and weaknesses are. What complementary assets does their organization bring to the negotiating table? If there is a choice of partners to make, time invested in researching a complementary fit could mean the difference between short-term failure and long-term success.

d. Understand your potential partner's needs and requirements. This may involve probing beyond their stated requirements. The better you understand their basic needs, the more likely you'll be able to effectively and efficiently reach a satisfying agreement that will stay mutually satisfying and beneficial.

e. Approach the effort from a problem solving perspective. Identify common, shared, or joint goals and objectives. Have faith in your own problem solving abilities. Understand the motivations for working together and establish acknowledge the commitment to do so. Trust that the cooperative effort will

work out and put trust in the other partner(s). Establish clear and accurate communications at all levels of the negotiation or interactions. Finally, develop a belief in the validity of the other partner's position - don't waste time demeaning the other partner's position. (Lewicki, pp.109-114)

While there are probably many more observations which could be derived from these examples, these are the ones which were most apparent from analyzing the thesis research notes and were in some cases stated by the research participants. The next section on analysis will summarize some of the additional data revealed from the CRDA negotiation process evaluation and from the participant perspectives.

9. ANALYSIS

The data collected and documented has provided a better understanding of the opportunities and challenges associated with transferring technology from U.S. federal laboratories to the private sector for the purpose of commercialization. The subsequent analyses will draw upon this data and address the original hypotheses which were formed from the background research and preparatory discussions. Therefore, each of the following sections will address one of the three principal hypotheses concerning awareness, barriers and the agreement negotiation process. The analyses will focus upon the qualitative thoughts and images identified by the research participants and upon the responses which could be quantified to some extent. Table 2 represents a summary of interview responses to assist in the analysis. Appendix D includes additional data used in these hypotheses evaluations.

9.1 Awareness is key

Hypothesis number one stated that awareness is still a key issue. Furthermore, it is believed that a low level of awareness of opportunities perceived by private industry, federal lab management and the lab research staff is expected to differ by segment; and that this difference forms a communication barrier which further impedes technology transfer progress. As the research responses indicate, there are many aspects of "awareness" which could be evaluated. Some of the more common ones which became apparent during this thesis research included awareness of:

Table 2: Summary of Interview Responses

| <u>Measurement</u> | <u>Lab</u> | <u>Lab</u> | <u>Comm</u> | <u>TT</u> | <u>Legal</u> | <u>Econ</u> | <u>Total</u> |
|--------------------------|-------------|--------------|-------------|-------------------|--------------|--------------|--------------|
| | <u>Mgmt</u> | <u>Staff</u> | <u>Mgmt</u> | <u>Specialist</u> | <u>Reps</u> | <u>_____</u> | |
| Number in sample (x/67) | 27 | 20 | 7 | 8 | 4 | 1 | 100% |
| % Viewed Positively | 89 | 85 | 86 | 100 | 100 | 100 | 90% |
| % Aware of opportunities | 74 | 40 | 71 | 100 | 100 | 100 | 67% |
| % Aware of TT office | 70 | 35 | 86 | 100 | 100 | n/a | 67% |
| % Aware of TT POC | 70 | 35 | 86 | 100 | 100 | n/a | 67% |
| % Involved in TT | 63 | 25 | 57 | 86 | 100 | n/a | 55% |
| % Involved in coop. R&D | 26 | 15 | 14 | 63 | 100 | n/a | 30% |
| % Aware of partner | 56 | 15 | 43 | 75 | 100 | n/a | 46% |

- technology transfer opportunities, policies or procedures;

- internal (organization) points-of-contact for technology transfer

information or help (offices or individuals);

- internally available technologies (e.g., general awareness of lab technologies and which ones could be transferred to external organizations) ;

- internal technology needs or requirements;

- internal awareness of external needs (e.g., laboratory awareness of commercial sector needs);

- externally available technology (e.g., from a commercial perspective, what is available in the federal labs and how accessible is it?)

However, for the purposes of this thesis, only the first two items concerning awareness of technology transfer opportunities and internal points-of-contact were formally evaluated.

To determine whether or not awareness of technology transfer opportunities, guidelines, policies and procedures was still a key factor affecting an organizations ability to transfer technology, all participants interviewed were asked the following question:

Are you aware of any recent opportunities and/or guidelines concerning the transfer of technologies funded by the federal government to the private sector? The interview responses are as shown if Figure 9.1.

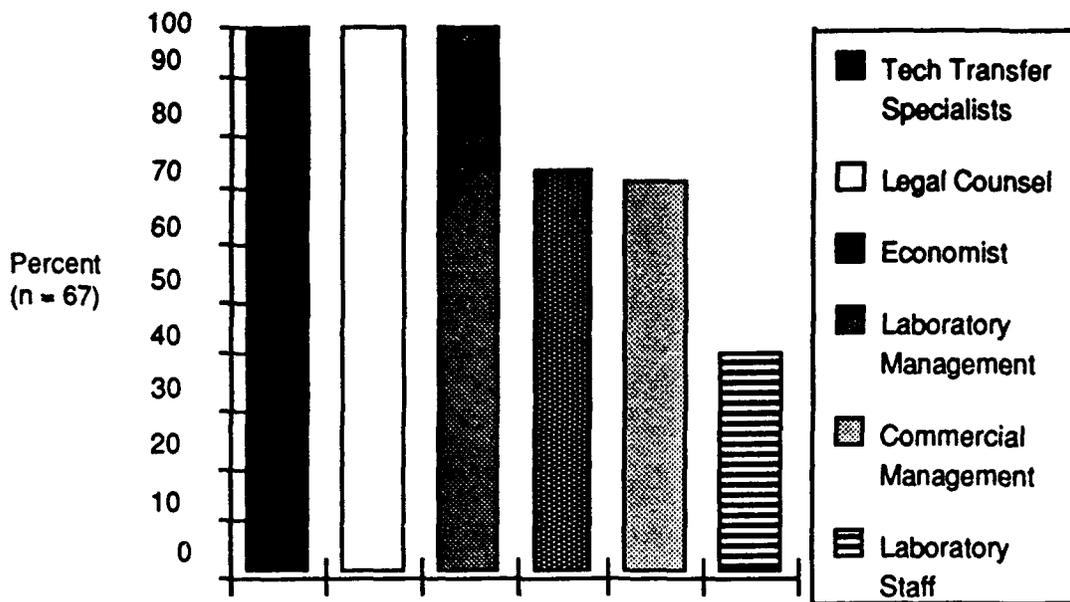


Figure 9.1: Level of technology transfer opportunity and guideline awareness

The data indicates the highest level of recognition among the technology transfer specialists and legal advisors. The 100% awareness level is not surprising result as it is a primary job responsibility of participants in this category to work out the details of such matters concerning technology transfer and cooperative arrangements. What would have been surprising is if the result had not been 100%. This would have spurred the need for additional analysis to determine why the awareness was less than complete and would have had education and training implications.

The international economist's level of awareness cannot be generalized as it represents a sample size of one. The main reason this interview was conducted was to provide a glimpse into the macroeconomic view of

technology transfer and cooperative research, and to investigate whether there were broader issues with greater implications than were apparent from the focused interviews from other sampled segments. The fact that these opportunities were viewed positively indicates to some extent the interest level and significance with which this topic is perceived at the macroeconomic level and its national implications.

The level of awareness of technology transfer opportunities and guidelines for federal laboratory managers was found to be just over 74%. This number indicates that roughly one out of every four laboratory managers do not have any awareness of such opportunities. Limited awareness at these key leadership levels is potentially one of the main reasons for the low level of participation by the labs in cooperative R&D arrangements. It seems logical that if the laboratory management is less than fully aware of technology transfer opportunities, they will approach any potential arrangements very cautiously and may avoid them all together since the new opportunities provide mechanisms which were previously unauthorized. In addition, incomplete or insufficient awareness at this level could be interpreted by the research staff who report to them as a lack of interest or support and this seems likely to have a negative impact on subordinate interest and enthusiasm.

While it was not surprising that nearly 90% of the laboratory management sample viewed this type of technology transfer opportunity positively, it is surprising that while 74% of the lab managers interviewed did have some awareness of recent opportunities and/or guidelines, so little has been done to

capitalize on these opportunities. At first glance, this relatively high level of awareness seems inconsistent with the hypothesis that awareness is a key issue and that through increased awareness enhanced technology transfer can occur. However, a deeper level of data analysis on this group's perception of barriers, indicates that awareness is one of the major barriers and in spite of the level of awareness or interest, the support and guidance from top management (laboratory commanders or directors) is critical to implementation and success. This was best reflected by one manager when he stated, "the philosophy of lab management is still a problem - we don't really have their blessing to do this type of tech transfer." As long as the top level laboratory policy is unclear and there's a lack of experience and positive attitude about dealing with cooperative R&D, even the greatest level of awareness and interest is likely to be stymied.

Interviews with participants from commercial management revealed similar results to those of laboratory management. Seventy-one percent of the private sector participants demonstrated some level of awareness of recent technology transfer opportunities and 86% viewed such opportunities as positive. This awareness again indicates the relative level of interest and importance perceived by the commercial sector. However, it also forces a second level analysis to determine why, if awareness and positive outlook are so high (71% and 86% respectively), is the relative level of cooperative research and development activity so low?

Further analysis of the data collected on private sector perspectives seems to provide some insight to this question. While many of the perceptions dealt

with the private sector aversion to government "red tape" or the historical difficulties in dealing with government rules on intellectual property rights; these comments do in fact provide some insight into the actual level, or depth, of awareness. Since the actual opportunities are in general greater than those perceived and the red tape is "less sticky" due to the nonapplicability of the Federal Acquisition Regulation, there seems to be a misconception or misunderstanding of the new technology transfer opportunities.

To summarize the data relevant to this hypothesis, while it is clear that the vast majority of potential technology transfer participants perceive the new type of cooperative R&D opportunities positively (90% average), it is just as clear that there is still a need to raise the level of awareness amongst the key participants (67% average awareness of some opportunity). The data shows that only about 70% of the management (laboratory or commercial) is aware of technology transfer opportunities and only 40% of the laboratory staff are aware. Action is needed to raise the level of awareness in both of these groups if the U.S. national objectives are to be achieved.

9.2 Key barrier is perceived government red tape

Hypothesis number two stated that a key barrier to technology transfer from federal laboratories is the perception of government red tape in establishing a cooperative working relationship. The data collected indicates that this perception can and does exist both within the federal laboratories and in the private commercial sector. The data which proves this hypothesis is the

qualitative data extracted from each of the interviews main thoughts or images, and the barrier identification sections. Eighty-five percent of the categories of barriers perceived by the laboratory and commercial sector management, laboratory staff and legal counsel dealt with some "red tape" aspect of communication, coordination or negotiation. Two important observations can be drawn from the analysis of these barrier categories. First, there is still such a limited amount of information available on actual cooperative agreements that many of the barriers identified by these groups are in fact envisioned or perceived and not actually experienced. Second, the vast majority of comments were based upon actual experiences the laboratories had with commercial entities through contractual arrangements. However, these "contractual arrangements" are not applicable to the new technology transfer mechanisms involving cooperative R&D agreements. The perception of laboratory-industrial interactions is dominated by the reality of a 40 year relationship tarnished by bureaucratic acquisition policies and procedures designed to promote competition not cooperation. Therefore, this confusion of the CRDA with the historical government-industry "red tape" contractual arrangements does appear to be one of the major barriers to overcome.

9.3 Understanding is the key to success

The third hypothesis stated that understanding and enhancing the negotiation process between the labs and commercial industry is a key to successful technology transfer through cooperative research and development.

To test this hypothesis, the perspectives of the research participants were analyzed to identify how many of the overall responses perceived a barrier specifically associated with negotiating a cooperative R&D agreement. Fifty out of 102, or 49% of the barrier responses identify an issue which directly deals with some aspect of negotiations, e.g., agreement terms, fairness of the deal, proprietary rights, or other details related to effectively communicating opportunities, expectations, commitment, etc.

While it may always be possible to interpret and perhaps group the participant's qualitative responses differently, depending on one's own background and biases, the data does seem to convey a fairly strong message about the key concerns and challenges. Of the data collected, no other single barrier or grouping of similar barriers conveys such a significant and logical message. Technology transfers through people. Cooperative research and development agreements are technology transfer arrangements hammered out through human interactions. These interactions highlight individual and organizational priorities, concerns and opportunities. Enhancing these interactions means improving the negotiation process through mutual respect and understanding. Greater understanding and cooperation is possible when you appreciate other's perspective or point-of-view. Hence the importance of understanding the perspectives of key participants in the negotiation process is validated.

10. RECOMMENDATIONS

The original objective of this thesis which was to understand the barriers, problems and issues surrounding technology transfer from U.S. federal laboratories to the private industrial sector for the purpose of commercialization and develop a set of recommendations for enhancing the transfer and utilization of federal laboratory technology. To accomplish this objective, scores of interviews were conducted with participants from the various sectors identified. Their thoughts, images, feelings and perspectives were recorded and analyzed to provide insights into the current mind set of the people most directly responsible for and involved with technology transfer. These insights, when combined with a brief historical perspective and the latest status of technology transfer legislation, opportunities, mechanisms and barriers, have allowed the author to prepare a series of recommendations which will hopefully assist in negotiating future cooperative research and development agreements. The following paragraphs represent these recommendations for each of the partners in the process.

10.1 General recommendations from the hypotheses analyses

Hypothesis number one stated that awareness is still a key issue. The second hypothesis acknowledged the red tape perception or misconception as the case may be and the third hypothesis recognized the importance of perceptions in the CRDA negotiation process. The validation of these hypotheses is cause for action. The action recommended is a multiphase

program which addresses the level of awareness of technology transfer opportunities perceived by private industry, federal lab management and lab research staff; tackles the differentiation issue surrounding technology transfer opportunities versus the perceived red tape of the government acquisition process, and; extends the awareness training to include negotiation and perspective sensitivity seminars for educating key participants in the process. The multiphase awareness and marketing program should include specific objectives and performance measures to better understand our current situation and allow for tracking progress. The recommended phases for accomplishing such a program might be outlined as follows:

Phase I: Implement an awareness expansion effort

- Sponsoring agencies and Congress must acknowledge their commitment to this national technology transfer initiative by providing funding for the establishment of significant technology transfer efforts within each federal laboratory. This will go a long way towards removing the doubt and ambiguity which currently surrounds the effort as viewed by the labs and private sector. With the opportunity and potential which exists in the federal labs, it is conceivable that eventually they may develop self-sustaining technology transfer offices. This could occur either through an affiliates program or from the licensing of lab technologies and the receipt of royalties. However, for the near term, top level commitment and funding support is desperately needed.

- An initial random survey should be conducted within each laboratory to ascertain the current level of technology transfer opportunities and

requirements awareness, and establish a baseline for subsequent performance measurement.

- CRDA awareness and training seminars should be organized within each federal lab to provide all laboratory management with the latest information available about such opportunities. Introductory mass information diffusion seminars should be held in which all laboratory research staff are "invited" (required) to attend. The idea here is to not change the laboratory or "corporate" culture, but rather to begin to change the organizational habits by letting people know that it's O.K. to wonder about, think through, and pursue other applications with commercial potential and identify possible beneficiaries and users. The timing is right for this type of promotion. The vast majority (90% average) within the laboratory and private sector view this potential activity positively and many are truly excited about the possibility of such opportunities. Unfortunately, many don't know these opportunities even exist or believed they weren't possible. In the laboratory, 60% of the staff and 26% of lab managers had no awareness of the recent cooperative R&D opportunities. Amongst the commercial entity managers surveyed, 29% had no idea that such opportunities existed, but most acknowledged the expertise of the laboratories and the huge commercial potential if an effective and efficient means of transfer "could" be found. Awareness promotion within the commercial sector must be implemented carefully and on a market segmented basis to be effective. Federal laboratory technologies and opportunities are likely to be viewed by the different commercial segments from different perspectives.

Many of the marketing type functions and new promotion initiatives sponsored by the Federal Laboratory Consortium are promising, but, as noted by the president of one of the larger private companies interviewed, "they lack sufficient manpower resources in the Federal Laboratory Consortium (FLC) to effectively execute technology transfer." What is envisioned and is recommended is some combined marketing effort which draws upon the national technology transfer expertise from a recognized focal point - like the National Technology Transfer Center; the regional contacts, knowledge and insights perhaps provided by the FLC, and; the in depth technical expertise available only in the laboratories from the staff and the technology transfer specialists.

Phase II: Eradicate the red tape perception

This thesis research indicates there is confusion between the technology transfer opportunities for government-industry interactions through CRDAs versus interactions through the historical contractual means. Much of the perceived red tape is directly associated with government contracts and the federal acquisition system. Since most commercial entities are at least aware of government contracts, they tend to associate any interaction with the government (such as agencies, military services, federal labs, etc.) with the red tape, difficulties and burdensome procedures. The majority of difficulties which commercial entities experience is due to the extensive and costly efforts to comply with the Federal Acquisition Regulation (FAR). And while it may be true that the government agencies are constantly trying to streamline the acquisition

process and make it more efficient, the image of the FAR and its perceived red tape are forever embedded in the minds of many commercial industry and government employees alike.

It is this image of having to deal with the FAR and its associated red tape which we must work to overcome. We will not easily change the minds or perceptions about working with the government if this image persists. Therefore, the recommendation is to disassociate the entire domestic technology transfer initiative from the acquisition and contracting system. Legally, this was made possible when Congress defined a mechanism called a CRDA which, by definition, was not and could not be a contract - and therefore is exempt from the burdensome requirements of the FAR.

The question of how to eradicate the red tape perception then becomes one of what to do to disassociate the CRDA process from the acquisition process. One recommendation is to stop advertising CRDA opportunities in publications which are typically viewed as contracting mechanisms such as the Commerce Business Daily (CBD) - or create a separate section within the CBD for advertising CRDA opportunities. While advertising in this publication may be one of the quickest ways of reaching a wide audience, it may not be hitting the right audience and almost certainly is adding to the confusion of contracting versus CRDA. In fact, advertising in the CBD may be doing more harm than good. It might be promoting the idea that if a company is willing to "cooperate" with a federal laboratory on an R&D project, the company may get their "foot in the door" for the lab's next commercial contract. This linkage, in fact, was an

observation made by a senior technology transfer specialist who had responded to commercial inquiries about cooperative agreements and the potential for follow-on contracts. What should be done is to clearly define a simple step-by-step procedure for cooperation and technology transfer which includes both the knowledge and the intellectual property rights mechanisms.

Phase III: Prepare for negotiations

As a final general recommendation for enhancing technology transfer through cooperative R&D agreements, we must acknowledge differing perspectives of the potential participants and prepare ourselves for the negotiations. How can this be accomplished?

The acknowledgement of different perspectives can only come about by forcing ourselves to stop - and consider what lies beyond our own walls. It comes from taking the time to think about what it is that is really needed by the other potential partners in a CRDA. And, it comes from caring in an honest and sincere way about the mutually beneficial final outcome and the effect on a long term relationship. Positive long term relationships constructed between federal labs and commercial entities can help dispel the misconceptions and create a greater community with a fuller appreciation of the contribution the labs have made and can continue to make for this country.

The preparations for negotiating a CRDA can begin by wondering how we can become more effective in selling our idea or persuading someone to adopt our point-of-view. This curiosity might lead some to dig into an interesting book on negotiation theory or practice. It might inspire others to attend a seminar or

take a course on the subject in order to learn more and understand better how to deal with others more effectively and pleasantly.

Finally, preparing for negotiations really means finding out as much about your potential partners as possible. It means doing your homework. Briefly stated, this is done by assessing the value of what it is you bring to the negotiating table, gathering as much key information about your counterparts as you can and having a firm grasp on your own organizations goals and objectives. The reasons for this type of preparation are to help you achieve a fair and equitable agreement by appreciating their situation and needs as well as your own, and helping them identify opportunities and alternative solutions which they might not have seen. This type of accommodating and considerate activity, when combined with a thorough understanding of your own goals, objectives and limitations, will go a long way towards enhancing the CRDA negotiation process.

10.2 Specific recommendations for research participants

10.2.1 Sponsoring government agency

The principal recommendations for sponsoring government agencies are summarized as follows:

a. Recognize the various views of CRDAs and the roles they play and use this information to target technology transfer enhancement initiatives. This research indicates that there are at least three different views of the CRDAs and the roles they play. The roles identified by this research are:

- as an innovative technology transfer mechanism to commercial industry
(Congressional view);

- as a supplemental source of R&D funding or contract alternative (labs &
HQ Agency view), and;

- as a mechanism to gain an inside technical or political edge on a
potential future government contract (industrial view).

b. Advertise. Move out quickly, the timing is right. In spite of the cultural barriers to overcome within the labs and industry, the overwhelming majority (90%) view this activity as positive so the resistance to changing old habits and implementing new initiatives will be low. Advertise technology transfer and CRDA opportunities. Alan Schriesheim, director and chief executive officer of Argonne National Laboratory (previously more than 20 years at Exxon Research and Engineering) stated that, "An aggressive campaign to inform industry about what the national laboratories can do for them could accelerate the [technology transfer] process. Conferences and workshops involving government and industrial participants could tell potential industrial partners of the positive experiences of current partners."(Schriesheim, p. 55)

c. Streamline the CRDA review process and delegate final review to the lowest practicable level. Recommend Agency HQ involvement only when requested. Only 10-15% of all USAF CRDAs required HQ modification. Consider the cost not only in terms of the approval delay, but in terms of the perceived red tape. Precedent already exists - let's just do it.

d. Integrate the CRDA process into the rest of the agency's business.

Develop a plan which clearly delineates the integration of and benefits received from incorporating the CRDA process into the Science and Technology investment strategy.

e. Tackle the question of equal opportunity of access and fairness immediately - develop the rules of engagement or guidelines for fairness. Recognize that even though the agencies need to be careful in creating a situation where a single company is given an exclusive use of technology, hesitation kills. Recall as an example that out of dozens of USAF CRDAs approved and pending, not one has yet experienced any problem concerning fairness.

f. Define for laboratories an allowable and correct way to use funds brought in under CRDAs. The laboratories are just beginning to sort this out and could really use some guidance and the confirmation of agency support.

g. Organize an expert panel to discuss and develop a policy addressing liability for technology transferred to a commercial product which ultimately causes some unforeseen damage - who's responsible?

10.2.2 Commercial management

Technology transfers through people. And, people need to inform and be informed about technology needs and potential transfer opportunities. The commercial industrial sector can and should speak out concerning their needs and requirements. The laboratories recognize that they could do a more effective job of transferring technology if they knew what the private sector

requirements were. The commercial companies recognize that the laboratories aren't aware or focused on commercial needs. Someone needs to take the initiative to bridge this understanding gap. Some of the relevant thoughts and recommendations drawn from this research are as follows:

a. Recommend the commercial entities take a proactive role and inform them how to establish effective contact federal labs and tell them:

- how best to meet your needs;
- how best to advertise available technologies, and;
- how to advertise CRDA opportunities.

b. Analyze the potential for your commercial objectives by gaining access to new federally funded technologies, leveraged technologies, special facilities, and expertise, which could make a CRDA relationship more profitable and less of an administrative headache than conventional contractual arrangements.

c. Help the labs reach both national local small businesses through company-laboratory (co-lab) networking and effective use of various business organizations. This clearly benefits the small companies, but also can benefit the larger corporations because frequently a large corporate entity will draw upon the innovative talents of a small company as a test bed or incubator for advanced new technologies and products. Similarly small businesses are usually suppliers of large business

d. Help the laboratories focus their technology marketing efforts by assisting in the selection of national and regional business publications including specialized technical publications. Recognize that careful selection of

regional publications can be more effective because they tend to be more directed and can have a larger regional audience than the more familiar national or international publications.

e. Take the initiative and don't wait for the federal government to define what a U.S. company is. Since there are still no federal guidelines to deal with the perceived limitation of domestic technology transfer to global (foreign owned or multinational) companies, these companies could take it upon themselves to effectively demonstrate sincere corporate U.S. citizenship. Show that if the benefit to the U.S. public (i.e., value added jobs, manufacturing, product availability, etc.) is greater than it would be from other arrangements (i.e., a U.S. owned company that does the majority of its design, development and manufacturing internationally) then it is in the best interest of the labs to proceed with the CRDA - in spite of where the corporation HQ may be. Negotiate the details in the CRDA in the best interests of the parties involved. Don't wait for a new federal law, regulation or policy - help set the precedent.

10.2.3 Laboratory management

When Congress passed the Federal Technology Transfer Act in 1986, in one fell swoop they provided laboratory managers with the greatest, most versatile technology transfer mechanism of all time (the CRDA) and one of the toughest challenges ever - to enhance U.S. economic and national security by transferring federal lab technologies to the private (and public) sector to get greater utilization out of the federal R&D investment and to help U.S.

companies regain a competitive advantage on the world market - without competing with the commercial sector, and - while ensuring fairness and equal opportunity of access when negotiating exclusive (or nonexclusive) licensing agreements for the commercialization of lab technologies.

After reviewing this challenge it's easy to see why these envisioned objectives, which the labs were encouraged to pursue, were all but cast aside for a few years. In the mean time, the Executive Branch and Congress did not rest on their laurels. Subsequent executive orders and legislation have come out each year since 1986 to further strengthen the commitment, broaden the participatory base and further encourage the federal laboratories to contribute to rebuilding America's competitive muscle. However, there is still an underlying suspicion that Congress may not know what they are asking or the feeling that "what Congress giveth one day, they can taketh away the next." Understandably, there is a concern within the labs about where to get the money from to establish and grow the technology transfer organization required to accomplish the envisioned goals, and; if the labs are able to siphon off enough of their budgeted R&D money to develop such technology transfer resources, will Congress then wake up to the recognition that they have forever changed the strategic direction of the federal labs, and amend the legislation to limit technology transfer activities.

Laboratory managers are faced with a strategic dilemma. Legislative acts and budgetary constraints practically force the federal labs to implement an aggressive technology transfer campaign to demonstrate the utility of their

facilities to the public at large. On the other hand, there is a deep-rooted concern that by establishing the kind of cooperative technology transfer activities required by subsequent agency regulations and policies, these activities will do irrevocable damage to the very same research and development foundation for which the United States is famous and which represents one of the few national activities that the U.S. can still claim some dominance in. The apparent complexity of the issues involved and the seemingly contradictory nature of the "technology transfer challenge" make this particular opportunity especially difficult to take advantage of and put the laboratories in a perceived position of "damned if you do - and damned if you don't."

In spite of the perceived difficulties, however, the majority of laboratory managers (89%) view cooperative R&D with industry positively. In spite of the fact that this intermingling with industry may create a publicly perceived loss of objectivity and threaten the federal lab's role as an unbiased evaluator, most laboratory managers believe it is time to try something different. Some of the more striking comments from lab managers concerning cooperative R&D included:

- We're encouraging it. In several programs it's the core of our proposal. I don't think we can operate any other way in the future.

- Fine idea. Cooperation is good. It brings what the market needs, what's marketable into the labs.

- That would be an extremely good situation. There's concern over COI

and patent protection, but the benefits could outweigh any problems.

- Great idea. Lab's role is to develop and transfer technology. We do pretty well on the development, but not on the transfer.

- It's terrific, but the laboratory infrastructure is not receptive.

- No problem, barring the charter which states we shouldn't selectively enhance the prosperity of any one company, this is easy to deal with. We want to stimulate outside activity.

- Excited. Enables the lab to fulfill the spirit and intent of the FTTA to get more out of the lab and is an opportunity for the scientists to get excited from working with the commercial sector.

- Feel very strongly that it would be a good thing for all of us to do.

- Very excited about engaging in those opportunities now.

- Great idea. Like to see more of it. Has limited areas of applicability. Has to be a profit in it.

Of the 27 lab managers interviewed for this research, dozens of relevant thoughts and ideas were presented for revitalizing the way their labs do "business" - including cooperative R&D efforts with industry and the expansion of a widely publicized and readily accessible technology transfer organization within the lab. Also, suggestions for enhancing technology transfer included introducing incentives for lab staff who do cooperative efforts, and encouraging them to participate in a technical society or other dissemination activity.

Therefore, my one recommendation to laboratory management is to listen

to your subordinate managers and act on their recommendations. Utilize the greatest resources and invisible assets within your organizations to unravel the mysteries of cooperative R&D. Ask for volunteers to participate in seminars and focus groups to discuss these new technology transfer opportunities and the unique implications of and solutions to the problems facing your lab. The level of participation may be surprising. This is one of the most important topics of this decade for the laboratories and most laboratory managers know it.

10.2.4 Laboratory staff

Only 40% of the laboratory staff expressed any awareness of technology transfer opportunities using a cooperative R&D mechanism. Roughly one third of those interviewed knew of a technology transfer office or a point-of-contact within the organization. Surprisingly, while many people are aware of the fact that technology transfers through people, and while this group of laboratory staff represent the real channel for transferring technology, only 25% had participated in any technology transfer activities to a commercial company and only 15% either were or had been involved in a cooperative R&D effort with a commercial company. These low percentages exist largely because the lab staff are unaware of the incentives and mechanisms for technology transfer.

What recommendations can be drawn from these statistics? They seem to confirm the sentiments identified earlier by one of the top laboratory managers. That is, "The lab's role is to develop and transfer technology. We do pretty well on the development, but not on the transfer." This thesis research has no way

of confirming how good or poor these technology transfer participation statistics are. On the other hand, intuitively they seem low if in fact the mission of the lab is to develop and transfer technology. The recommendation therefore is to search out opportunities for increasing this level of participation. While working on a research or development project, focus on achieving your principal mission objectives, but allocate some time to consider alternative uses of the technology. Opportunities currently available could make this a professionally stimulating and financially rewarding digression for the staff member and the lab.

10.2.5 Technology transfer specialist

There are two recommendations for this group of individuals. First, you're doing a great job with the limited resources at your disposal. There is little doubt that the degree of internal familiarity within the lab is due largely to your advocacy. However, there is still a tremendous job to do concerning extending the awareness level in both breadth and depth in both the management and the research staff. Second, lobby within the lab and at agency HQ for greater support and funding for regional marketing. Continue to work closely with the FLC and to the maximum extent possible, act as an extension of their activities. A coordinated and focused effort will accomplish more than any individual activity.

10.2.6 Legal counsel

One of the details that became crystal clear during this thesis research was the central role the patent attorneys and legal counsel play in achieving technology transfer through cooperative research and development. For the two primary laboratories researched, the agency HQ patent attorneys contributed in major ways to the advocacy at all organizational levels, the drafting of the critical clauses for the agreements, and in the negotiations. Of everything observed while interviewing the legal team there was only one concern and therefore only one recommendation. In light of the current CRDA negotiation workload and the projected increased activity as the word spreads and opportunities are realized, it is not clear how the HQ legal counsel can maintain the pace - especially with the projected human resource losses due to attrition, retirements and cutbacks over the next few years. Therefore, the recommendation for legal counsel is normalize the workload by:

- shifting the work back to the lowest possible organizational level;
- focusing personal activities on the next phase of CRDA development, beyond individual lab education and training, and;
- develop an advocacy group aimed at retaining and recruiting the necessary replacement lawyers.

11. SUMMARY AND CONCLUSION

This research was initiated to address the question of what can be done to more effectively and efficiently transfer and utilize federal laboratory technologies in order to achieve greater economic and national security, and to strengthen U.S. competitiveness. As discussed in the Recommendations chapter, what can be done depends on which segment of the community the technology transfer participant represents. However, research results indicate that several courses of action are required to accomplish a greater degree of technology transfer. First, a major awareness campaign needs to be initiated to spread the word about new cooperative research and development agreement (CRDA) opportunities. This will help to expand the horizons of both federal and commercial sector potential partners. Second, the new government-industry cooperative arrangements need to be clearly distinguished from the federal acquisition system to dispel the perception of government red tape; and these CRDAs need to be negotiated and processed more quickly and efficiently to confirm this distinction. Finally, greater understanding and appreciation of the perspectives and needs of potential cooperative participants must and can occur to improve the efficiency and effectiveness of negotiating technology transfer cooperative research and development agreements.

In summary, the thesis defines technology transfer in this context as the transfer of federal laboratory technologies to the domestic public and private sector. It explains through examples and expert opinions why is it important to address domestic technology transfer now; and identifies what enhanced

technology transfer is expected to accomplish in terms of socio-economic and national security benefits. By answering these questions the paper provides some insight and understanding of the issues and concerns associated with technology transfer and identifies the most important aspects for further research emphasis.

This thesis reviews some of the history of technology transfer and addresses some of the key thoughts about the role of the federal government in technology transfer. Since so much has been done recently to promote the transfer of technology from U.S. federal labs to the corporate industrial sector, for the purpose of commercialization, the thesis presents the present status and summary of legislation, mechanisms and barriers associated with technology transfer.

Since one of the main objectives of enhanced cooperative research is to ensure more rapid application of federally funded research, a series of questions were prepared to guide the research and help focus on the impediments. Answers to critical questions indicate the importance of negotiations in the cooperative research and development process and the relevance of individual perspectives in these negotiations. Hence, major sections of this thesis address pertinent aspects of negotiation theory and the perspectives of key participants in the technology transfer process. Cooperative Research and Development Agreements (CRDAs) are identified early in the research as perhaps the most important new mechanism or tool for accomplishing the technology transfer mission and speeding-up the technology

application process. Therefore, a significant amount of time and effort was spent in documenting and analyzing the CRDA process from an interactions and negotiations perspective.

The research included extensive background literature reviews and formal personal interviews with representatives from three federal laboratories, six commercial industry companies, and two federal agencies; as well as dozens of informal discussions held with representatives for industry, government and specialized technology transfer organizations such as the Federal Laboratory Consortium and the international Technology Transfer Society.

Within the organizations formally interviewed, the key participants were identified by position type and the data collected for each position type was then grouped to perform a type of segment analysis. Each of these organizations or human resource positions plays a critical role in the transfer of technology through cooperative research and development agreements. The complex set of needs and motivations which drive individuals and organizations into entering into these highly interactive arrangements is still seemingly not well understood. However it is hoped that through the research accomplished in support of this thesis, greater insight into the perspectives and practices of the various potential participants will represent some degree of progress.

One of the main perspectives identified by this research is the adversarial perception of industry by the federal labs. This perception has been fostered largely through the contractual arrangements which have been the dominant

form of the relationship for many years. While it should be noted that this perception presents a real problem for those interested in negotiating CRDAs, it also represents one of the main perceived problems with government-industry relationships in general. Analysis of this situation recognizes the importance of conducting CRDA negotiations with a mutually beneficial win-win attitude. It seems, perhaps, that this approach should also be applied in general to the negotiation of government contracts with industry. The existing contractual-adversarial attitude must change if domestic technology transfer objectives are to be achieved, because this attitude does in fact affect the awareness relationships between industry and government which are crucial for conducting cooperative research and development. Viewed from this broader perspective, expanded CRDA operations and more cooperative government-industry contractual negotiations seem to be part of the same economic strategic objective aimed at strengthening U.S. national security and competitiveness. When the U.S. government and industrial sectors understand each other better and recognize the necessity for approaching all interactions with a win-win attitude, only then will these sectors begin to develop the confidence necessary in each other to accomplish the hoped for gains in national competitiveness.

An overall evaluation of this thesis might indicate that the research raises as many questions as it answered. This is probably true. In fact, at this point, it is quite clear that there are no simple answers to the question which generated this thesis. But, there are quite a number of good questions which remain to be

addressed. Among them are questions like:

- What "business" are the labs in?
- How do we as lab managers, sponsoring agencies, or a nation want to strategically utilize the federal labs, and; where does domestic technology transfer fit into their mission statements?
- Where does domestic technology transfer fit into the sponsoring agencies' strategy?

At a higher level of analysis, the research can be used to identify ways to strengthen and focus the technology transfer effort. A technology transfer policy needs to be developed, as part of an overall national or at least agency strategy, to focus on programs that align the capabilities of the federal laboratories to the needs of industry. The agencies and labs should establish an aggressive national campaign to market the federal laboratory technologies and cooperative opportunities. The campaign should address technology transfer opportunities, successful examples, and policies - on cutting out the red tape and speeding negotiation and approval times. The agencies and laboratories should also advertise their ability to assign patent and other intellectual property rights which have long been perceived as a stumbling block for working with the government.

In conclusion, there are a plethora of enhancements which could or should be done to strengthen the U.S. domestic technology transfer program and hence U.S. competitiveness. The various potential public and private

participants in this process should move out quickly and forcefully to gain the maximum multiplicative effect of the government's \$70B+ annual investment in R&D. Commercial entities that can learn swiftly how to work with federal labs will find the greatest selection of "partners" and could capture a greater share of the economic benefits of this federally funded technology. Federal laboratories that figure out the balance between government agency sponsored research and cooperatively extended research activities, could supplement or stabilize their R&D budgets during these times of fiscal uncertainty and help to stimulate the type of competitiveness gains hoped for by U.S. national leaders.

However, such efforts to use the federal labs to stimulate competitiveness must be kept in perspective. This sentiment is echoed by Alan Schiesheim, director and CEO of Argonne National Laboratory as he stated, "Encouraging (technology transfer) efforts must be kept in perspective. Competitiveness is not purely a technical matter. It involves a complex of financial, economic, regulatory, and social issues, many of which national laboratories are ill-equipped to handle. Panic about the nation's competitive position cannot be allowed to distort the laboratories' missions as established by their parent agency. Success or failure in technology transfer, after all, is determined in the marketplace, and industry is far better equipped than government to assess future market demand and identify products to satisfy it. At the same time, global competitiveness compels a search for more realistic ways to bring industry and the national laboratories together." (Schiesheim, p. 58)

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Appendix A: Technology Transfer Thesis Research Lab Questionnaire

TECHNOLOGY TRANSFER THESIS RESEARCH LAB QUESTIONNAIRE

Date: _____

1. When you think of working with industry, what thoughts or images come to mind?

2. How would you feel about conducting cooperative research and development with a commercial company?

3. What do you personally view as the **top three barriers** to conducting cooperative research with industry?

(a) _____

(b) _____

(c) _____

4. Are you aware of any recent opportunities and guidelines concerning cooperative R&D, transfer, and licensing of technologies funded by the federal government to the private commercial sector?

Yes _____ No _____

4.a. If yes, do you know who to contact for additional information and/or help in conducting such activities? Yes _____ No _____ i. If yes, who is the focal point? Name: _____

5. Are you now, or have you been involved in either a technology transfer or cooperative R&D effort with a commercial company?

TT _____ CRDA _____ None _____

5.a. If so, can you name of the Co. and a POC?

6. General Comments:

Mgmt. _____ Staff _____ Name/Pos _____

Appendix B: Technology Transfer Thesis Research Commercial Questionnaire

TECHNOLOGY TRANSFER THESIS RESEARCH COMM QUESTIONNAIRE

Date: _____

1. When you think of working with U.S. Federal Labs, what thoughts or images come to mind?

2. How would you feel about conducting cooperative research and development with a federal lab?

3. What do you personally view as the **top three barriers** to conducting cooperative research with a federal laboratory?

(a) _____

(b) _____

(c) _____

4. Are you aware of any recent opportunities and guidelines concerning cooperative R&D, transfer, and licensing of technologies funded by the federal government to the private commercial sector?

Yes _____ No _____

4.a. If yes, do you know who to contact for additional information and/or help in conducting such activities? Yes _____ No _____ i. If yes, who is the focal point? Name: _____

5. Are you now, or have you been involved in either a technology transfer or cooperative R&D effort with a commercial company?

TT _____ CRDA _____ None _____

5.a. If so, can you name of the Co. and a POC?

6. General Comments:

Mgmt. _____ Staff _____ Name/Pos _____

Appendix C: Full text interview Example #1

Dr. Lab Staffmember, Staff, Contact #, Date interviewed

1. 2 classes - big boys and small start-up (20-50 people) most new jobs from this small group. Most new technologies from these start-ups this is likely to be where the action is - it is a magnet to draw aggressive and creative people and it is a way the company can make a lot of money. If your serious about TT, focusing on small technology companies is best - typically, company will build a pre-prototype and subsequently license it to a big company for the mfg. Nice stepping stone and utilizes the complementary capabilities of both the small and large companies. If the AF is serious, that's the way to do it - use the small companies to develop a tech and then help them get together with the big companies to transfer the technology to the consumer markets. Second, the wrong way is to go through venture capitalists - they only bring money and only focus on a single implementation - too conservative an approach - the new tech needs to be developed in a parallel application to pick up on the multiplier effects - venture capitalists are too serial for the process to work well.

2. "Smashing idea!" I think the lab should set up channels to receive grants from carefully screened companies to work out with the lab and work on technology general enough to be of benefit to the whole country - broader charter - give small amounts (1-2 million \$ per year max) and the company gets first opportunity for license agreement. This would lead to: sensitizing people at the lab to consider the world and a broader lab charter to develop tech for general use in certain specific areas. - and also make available to people inside the lab the tech at the private company to help the lab.

3. a. management in industry is backward on how they inject new technology.

3.b. industry has too short a time line, the one year horizon can't work well.

3.c. NIH - these are the problems with the large companies and the reasons for going to a small company first with the TT to avoid these same problems. Top management in the lab are afraid because they don't know what's going to happen 5 years from now - their whole careers have been built on these \$30M+ contracts and simply don't know how to bring along smali projects. - Staff are way ahead of management on having ideas.

4. Yes, x

5. TT, a. Negotiations are at a critical junction now and so the details can't be discussed. come back in 2 weeks.

6. The problem is not technology per se - it the TT process. Two or three things at the lab that can be done in general management. We're basically an agency lab. The projects are too well focused - trend has been on specifying and accounting too much - if the lab did exactly what the agency told them to do... there would be a real mess. There has to be a certain flexibility but I think there would be a tremendous gain if there was a base of flexibility. 20-30 years ago flex was greater - the price paid is productivity has dropped off - the staff don't want to lay their careers on the line by taking risks. There is no time to think and invent. There's a feeling that if it CAN be specified, it shouldn't be brought to the lab in the first place and the lab should do only things that can't be specified! General gain could be achieved if more flex were built into the whole thing and could reach down to the staff level. Second thing is to try to motivate people - \$100K tax free to staff for the brightest new idea would motivate a lot of people. It would need to be for extraordinary. Need to single out tech quality per se. Viewpoint is that if you believe all great ideas have not been invented then how do you find these new things. Get smartest people and turn loose and allow 25-50% free time to invest and get 1 great idea per year - process is that try to go in any random direction. Depends on time perspective on goals - sees as only process of generating new tech break-throughs - small companies are where the action is - small companies invest in federal labs to work with labs then transfer to big co for mfg. There's even a problem of transfer within the labs. He thinks there's a lot of room for improvement - now operating at only 5-10 % efficiency for generating new technologies. Believes the process could be increased to 60% without any major expenditure. 80% of problem is psychological (cultural) staff is reluctant to get into new areas. Higher management, under tight schedule from sponsor - give message to staff to "just do the job". Higher level management offices - they don't want to hear about speculative efforts - they want hard cash, solid, big contracts, sponsored research. also, the highest level managers split the technology landscape into pies and one section can't compete against the other sections - lots of pressure to stay inside your little niche - slows down the whole process. In big company a new tech the lab tech is a threat so they don't want to incorporate the new tech. On new technology x - the lab solved the problem, but there is tremendous inertia to overcome - the lab would have no trouble transferring into commercial market if given the opportunity to work with the Japanese (they're 100x more aggressive) willing to accept technology 5-10 years early as an investment before profit. This is a great political problem however. Irrationality to process from American companies - they won't accept the technology from the labs, but they don't want the foreign competitors in the commercial market to get it.

- emphasized need for small hi payoff technology which can't be justified as big lab projects but provide a capability the govt needs but can't seem to justify until there's a commercial program capability.

- advantages to lock in technology at a rawer state to see these early small size technologies before filtering
- need to set up system to get things not filtered by lab mgmt levels
- need to find new ideas to make better lab and products
- can get access to new ideas this way
- sample from all groups throughout the labs to get new ideas

Appendix C: Full text interview Example #2

Dr G. Legal Counsel, Office, Date, Contact #

1. To try and overcome skepticism in industry about working with Govt., ie. belief there's too much red tape and they have to give up too many rights. There's too negative an input.

2. In favor of, beneficial "greatest piece of legislation out of congress in years - win-win situation for govt and industry.

3.a. lack of understanding of where to go (which companies) have need, reviewing official is too high on chain - needs to be in lab itself. AF Academy does it right. Lab Dir and reviewing official at the lab. Lab perhaps could have Lab commander as reviewer.

3.b. Too much mgmt from high positions within govt (labs to do CRDAs) according to legislation.

3.c. Awareness within lab - the word isn't out in the labs - not implemented - or word is out but not implemented in more places.

4. Yes

4.a. Yes, Mr. x

5. n/a

6. Problems of copyright on SoftWare - patents can be done but not copyrights in govt. Legislation pending to enable govt labs to copyright. SW if it came out of a CRDA - can own but not obtain as a result of govt work.

- more effort to publicize our technology, or by training own lab people to do it
- FTTA best piece of leg. will hopefully turn the trend of loosing to foreign competitors

- limited restrictions on foreign company concerning mfg and foreign companies
- benefit of population, but disadvantage of not owned by the US if mfg by a foreign company.

Appendix C: Full text interview Example #3

Mr.I., VP for R&D, contact #, Date

1. confusion of ownership of intellectual property - inability to protect company property - RED TAPE

2. Positive except don't have a product in mind. unlikely that many products in our business would be same - basic tech could be mutually benefit - unlikely to have compatible interests - resource to resource basis we are an affiliate at JPL and try to do this type of cooperative work.

3.a. basic problem is cultural - we get most from tech when we own it. Lab gets most from benefit from tech when they publish it. - it's just a different way of getting benefit.

3.b. also same problems with universities and publishing results - different motivation.

4. Y

4.a. Y, Mr.C.

5. TT and CRDA. CRDA is a joint venture and funding processor technology in next level of completion, worked with fed lab to modify a device to provide more control for microprocessor controlled fireworks.

6. Is the arrangement with lab a formal agreement? Yes, but it's a blanket agreement w/lab in Affiliates program. They solicited the industrial programs. Company pays \$50-100K per year and basically gets that much work out of lab. Above and beyond that, the labs bill for payment on specific costs.

- When signed with lab it's actually x, all is handled via x which agreed not to publish (delay publishing) work which is being exploited by company.
- 6 months to negotiate the deal with lab - we can't ever explain that to them - they will walk away before changing culture
- because the rewards for technical people are not just monetary - get intellectual return for work
- our (industry/company) rewards are something else (modified).
- In NASA work (of 60's), there was a double return, there were so many spinoffs and it happened so quickly we could get a return.
- now it's churning out stuff slowly and methodically and it happens over a large period of time.
- I attended a meeting recently on the privatization of space efforts and saw the govt people complaining and bitching and I thought "... it's a mess, but you're the guys that created it!"

- How could you benefit from space tech? - its a cultural thing, very difficult.
- we still do \$8-10 M a year in basic R&D contractually done. -- still battle over who owns it -- culture at our company is " if we pay for it, we own it."
- I feel very positive about CRDA work - want to try to get involved in. - the federal lab resources are phenomenal"
- concerning lab, - "probably one of the finest research institutions in the world!"

Appendix D: Technology Transfer Thesis Data Base

| Position | Main Thought |
|----------|--|
| CM | large number of independent labs insulated from industrial sector |
| CM | national labs, natl expertise, member of family, tied into industry |
| CM | labs are great opportunity but get bogged down |
| CM | difficulties of monetary transfers, accounting constraints |
| CM | confusion of ownership of intel. prop-can's protect company property-red tape |
| CM | concerns over competitive vs. interactive nature of labs |
| CM | now working on s/w copyright and changes in patent law |
| ECON | "People sense that the system doesn't work and often blame the labs-no easy way to judge |
| LM | Complementary |
| LM | company dependent, variable quality |
| LM | level of commercial expertise and complementary nature |
| LM | low cultural impetus for transferring technology |
| LM | Profit motivation induces communication difficulties |
| LM | contractual relationship, emphasis on purchasing |
| LM | getting industries perspective is important part of resr |
| LM | large scale support - deep bench, welcome support from industry |
| LM | lab perspective on cost/profit considerations must change |
| LM | Multiple levels of lab mission must be considered |
| LM | <i>contract orientation, making sure industry meets requirements</i> |
| LM | lab does many levels of TT, industry should start here and expand |
| LM | contracts perspective, we/they need to be willing to invest |
| LM | If lab is to work with industry it must become faster |
| LM | industry is profit driven with variable competence |
| LM | must consider whether lab is a potential competitor |
| LM | variability of quality of capabilities in industry, careful partner selection |
| LM | long history of informal cooperation with industry |
| LM | concern over preferential treatment and equal access |
| LM | willingness on lab's part to do TT, but difficulty in doing |
| LM | concern over multiple roles lab plays with industry |
| LM | the possibility of commercializing a lab product |
| LM | <i>view industry as contractors, responding to our requirements</i> |
| LM | not familiar with industry, work more with univ |
| LM | industry doesn't do a lot of what we do - they have helped by taking on s/w distribution |
| LM | TT to commercial sector moves into the realm of religion and politics |
| LM | greater opportunities than previously believed |
| LS | industry overly protective |
| LS | one-on-one collaboration and communication |

Appendix D: Continued

| Position | Main Thought |
|----------|---|
| LS | industry is reluctant to do things a different way, NIH |
| LS | Industry has a different perspective- profit driven |
| LS | don't understand concept |
| LS | view industry as contractors and users of lab technology |
| LS | No lab procedures, concerns of fairness issues and legal constraints |
| LS | Structured, formal, expensive, why does the small co bother |
| LS | view industry as contractors only |
| LS | view industry as contractors |
| LS | great frustration, tedious and slow and industry doesn't absorb tech well |
| LS | views industry as contractors, salesmen, company reps |
| LS | view industry as contractors, science shops not drilled in mgmt techniques |
| LS | industrial support to govt in form of quick reaction time on services difficult to obtain |
| LS | view industry as contractors, not a lot of technical interaction |
| LS | variety of industrial competency, high cost of commercial support |
| LS | generally industry can move fast to do studies we can't |
| LS | view industry as contractor, they provide product |
| LS | involvement in contracts and collaborations |
| LS | industry in support role to extend capabilities to do hardware development for lab |
| Legal | overcome skepticism in industry about working with Govt |
| Legal | Industry wants things quickly and labs can't respond fast |
| Legal | procurement contracts |
| Legal | corp concern about getting tech to give strategic edge |
| STT | Nonprofit initiatives are needed to enhance tech transfer |
| STT | industry is focused on specific technology, profit motive |
| STT | to dispel notion that govt and industry are adversaries |
| STT | different cultures of organizations |
| STT | industry is receptive but greater marketing of lab tech is needed |
| STT | good idea, but not well enough understood |
| STT | We only recently got approval to do significant work w/industry |
| STT | Interest in involving univ, labs and industry in TT work |

Appendix D: Continued

Position Barrier 1

| | |
|------|---|
| CM | tech is not developed with commercial interests in mind |
| CM | lawyers getting involved working details of agreement |
| CM | Info flow, we don't know what's going on in labs |
| CM | reward system on both sides/motivation |
| CM | cultural - we get benefit from owning/profit, labs benefit from a different way |
| CM | Interest in process technology which doesn't spinoff well |
| CM | COI issues |
| ECON | seeming inability to establish a long term relationship between labs and industry |
| LM | Backward industry mgmt |
| LM | proprietary information issues |
| LM | perceived loss of lab objectivity |
| LM | industrial lack of resources for long term resr |
| LM | different cultures/communication patterns |
| LM | limited distribution of research results |
| LM | constraints on publication, nondisclosure agreements |
| LM | equal opportunity of access to lab technology |
| LM | perceived competition, industry not happy about some lab R&D |
| LM | historical bias - never done it before |
| LM | lack of knowing which companies to go to |
| LM | philosophy of lab mgmt- we don't really have their blessing |
| LM | a sense on industries part that the effort won't lead to profits |
| LM | TT is not in our outlook, need to change way of thinking |
| LM | lack of history for process |
| LM | COI and appearance of unfairness |
| LM | a lot to do with lawyers and the legal aspects |
| LM | federal procurement regulations, too rigid |
| LM | top level lab policy is unclear on taking money from industry for research |
| LM | instilled, how to do within confines of lab structure |
| LM | takes a lot of time and effort, both parties need to be motivated |
| LM | industry can be overly concerned, excessive proprietary nature |
| LM | industries profit orientation (short term) |
| LM | since we're not doing it officially, nothing gets in the way |
| LM | no fundamental barriers |
| LM | equal opportunity of access- fairness issue |
| LM | sets up a new lab bureaucracy but no funding to do job |
| LS | lab policy status or path |
| LS | whole security aspect - critical technologies issues |

Appendix D: Continued

Position Barrier 1

| | |
|-------|--|
| LS | ownership of intellectual property |
| LS | Lab Policy |
| LS | don't understand |
| LS | proprietary limitations |
| LS | would have to be OK with the research sponsor |
| LS | risking career, not a top priority with management |
| LS | concern over public perception, don't want to look like hiring out |
| LS | difficulty in finding civilian match |
| LS | no show stoppers |
| LS | COI, ethics, opinion in small community |
| LS | don't see it happening, lab people want to do hands on work |
| LS | bureaucratic and legal roadblocks |
| LS | contractual obligations |
| LS | industry is apprehensive about sharing data |
| LS | deadlines we have to get scientific reports in from labs |
| LS | don't know of any barriers |
| LS | seems like bulk of advantages are for the corporation |
| LS | lack of understanding on industrial part concerning relationship and opportunities |
| Legal | lack of understanding of where to go, which companies |
| Legal | slowness in response from HQ |
| Legal | govt not having ownership rights is major problem |
| Legal | if corp gets exclusive rights, what's it cost |
| STT | difference in POV from procurement and buying to facilitator and conduit |
| STT | finding the specific match, industrial partner |
| STT | attitudes within labs, cultural, labs not business oriented |
| STT | cultural change needed |
| STT | reward/motivation of lab staff |
| STT | |
| STT | previously not legal authority |
| STT | need for consistent model agreement to expedite process and reduce analysis time |

Appendix D: Continued

Position Barrier 2

- CM lack of sufficient manpower in the FLC to effectively do TT
- CM concern over potential for significant flow of profit
- CM mechanisms for getting data out of labs in timely way don't exist
- CM geographical separation/communication and sharing
- CM different motivation- more like univ, need to publish for recognition
- CM perspective that expansion of fed lab effort is helping foreign competitors
- CM problems with govt. published (NIH) guidelines and nonavailability
- ECON best way to xfer tech is to xfer people- labs need to find way to xfer people to industry
- LM industry too near term
- LM
- LM inability to find complementary industrial partner
- LM NIH
- LM loss of unbiased status/competitive alignment
- LM concern over outside influence, loss of control
- LM need for quid-pro-quo and truly cooperative effort
- LM industry concern over proprietary agreements
- LM concern over national security over classification
- LM need medium other than licensing office to work through
- LM possible legal problems
- LM in doing TT, the lab creates their own competition
- LM the procurement system doesn't encourage it
- LM applications issues, our experience not needed in comm sector
- LM implementation details, negotiated positions
- LM patent protection and ownership of technology
- LM proprietary nature of TT, ties our labs hands
- LM lack of experience and positive attitude on part of contract staff
- LM research would have to be mutually beneficial
- LM agree on levels of funding that makes it worth the effort
- LM must be corporate sponsorship - lab sponsor must see as good
- LM companies concerned over impact of patent agreement
- LM differences in pay scale - salary level
- LM
- LM finding topics of mutual interest
- LM legal obstacles
- LM questions of fairness on how to select companies for CRDAs
- LS lab flexibility and independence
- LS
- LS expectations of lab employee share

Appendix D: Continued

Position Barrier 2

| | |
|-------|---|
| LS | lab reluctance to get in too deeply, inconsistent goals |
| LS | |
| LS | can't get enough details out of company |
| LS | |
| LS | better people won't want to get involved |
| LS | |
| LS | concern that industry is just after a future govt contract |
| LS | |
| LS | |
| LS | it's the reason industry exists, not a realistic way of doing business |
| LS | govt afraid somebody would make money |
| LS | it's a pain to work with industry (contractual grief) |
| LS | concern over proprietary info - lockout govt |
| LS | difficulty in keeping communication flow open |
| LS | |
| LS | |
| LS | lab reluctance to seek out and communicate to potential companies |
| Legal | too much micro mgmt of CRDA process, delegate more |
| Legal | terminology (having to learn new technology) |
| Legal | govt inability to protect the intellectual property either brought to or <i>created by parties</i> |
| Legal | understanding if nonexclusive rights, what's benefit to corp |
| STT | need incentives, motivation for lab staff |
| STT | time constraints to get CRDA out door |
| STT | attitude within industry, perception of govt red tape |
| STT | all the legal issues |
| STT | CRDAs don't always lead to tech transfer |
| STT | |
| STT | lack of awareness |
| STT | need to develop a group of standard alternative clauses for CRDAs |

Appendix D: Continued

Position Barrier 3

CM no track record to give industry confidence or value of tech
CM details of the negotiations
CM
CM financial exchange and intellectual property rights
CM
CM COI on competition issue and mfg processes
CM Freedom of information act concerns
ECON many believe lab tech should be available to all industry-questions of
improper lab use
LM NIH, mgmt risk averse
LM
LM
LM
LM marketing long term investment prospects
LM concern over loss of privileged 3rd party position
LM details of arrangements
LM
LM
LM need way of increasing industry awareness
LM
LM
LM the lab is not structured to provide TT
LM
LM how to do TT with our type of lab
LM need for rules up front on TT process
LM coordination of physical arrangements, mechanisms
LM
LM
LM substitutes for funding
LM
LM length of time it takes to make an agreement
LM industry taking advantage of govt facilities w/o repayment agreement
LM
LM making industry aware of lab work
LM who pays for the TT?
LM concern over satisfying COI requirements in FAR
LS security of resr results due to commercial instability
LS
LS
LS

Appendix D: Continued

Position Barrier 3

LS
LS
LS
LS not where glory is for govt scientist
LS
LS
LS
LS
LS Govt provides money and people don't want to stop research
LS more legal hangups than scientific
LS
LS
LS
LS
LS understanding within our own system
Legal awareness within labs, the word isn't out yet
Legal
Legal
Legal if derivative tech is developed from lic. tech, can corp keep rights
STT middle management is not convinced of the need to do TT
STT
STT
STT understanding that TT is part of good R&D management
STT legal and negotiations problems
STT
STT lack of mechanisms
STT concern over intellectual property rights

Appendix D: Continued

| Position | Feelings | TT Aware -ness | POC Aware -ness | POC Office Name | TT Involve -ment | CRDA Involve -ment | TT CRDA Name |
|----------|----------|----------------------|-----------------------|-----------------------|------------------------|--------------------------|-----------------|
| CM | P | Y | Y | Y | | | |
| CM | P | N | Y | Y | Y | N | N |
| CM | P | N | N | N | Y | N | N |
| CM | P | Y | Y | Y | N | N | Y |
| CM | P | Y | Y | Y | Y | Y | Y |
| CM | P | Y | Y | Y | Y | N | Y |
| CM | U | Y | Y | Y | N | N | N |
| ECON | P | N | N | N | N | N | N |
| LM | P | Y | Y | Y | Y | N | proprietary |
| LM | P | Y | Y | Y | Y | Y | Y |
| LM | N | Y | Y | Y | Y | N | Y |
| LM | P | Y | Y | Y | N | N | Y |
| LM | P | Y | Y | Y | Y | N | Y |
| LM | P | Y | Y | Y | Y | N | Y |
| LM | P | Y | Y | Y | Y | N | Y |
| LM | P | Y | N | N | Y | N | Y |
| LM | P | N | N | N | | | |
| LM | P | Y | Y | Y | Y | Y | proprietary |
| LM | P | N | N | N | N | N | N |
| LM | P | Y | Y | Y | Y | Y | Y |
| LM | P | Y | N | N | N | N | N |
| LM | P | Y | N | N | N | N | N |
| LM | P | Y | Y | Y | Y | N | Y |
| LM | P | Y | Y | Y | Y | N | Y |
| LM | P | Y | Y | Y | Y | Y | Y |
| LM | P | Y | Y | Y | Y | N | Y |
| LM | P | Y | Y | Y | Y | N | Y |
| LM | P | Y | Y | Y | Y | N | Y |
| LM | P | Y | Y | Y | Y | Y | Y |
| LM | P | N | N | N | N | N | N |
| LM | U | N | N | N | Y | N | N |
| LM | P | Y | Y | Y | Y | N | Y |
| LM | P | Y | Y | Y | Y | N | Y |
| LM | P | Y | Y | Y | Y | Y | Y |
| LM | P | N | N | N | N | N | N |
| LM | P | N | Y | Y | N | Y | N |
| LM | P | Y | Y | Y | N | Y | Y |
| LM | U | Y | Y | Y | N | N | N |
| LM | U | Y | Y | Y | Y | N | N |
| LS | U | Y | N | N | Y | N | Y |
| LS | P | N | N | N | N | N | N |
| LS | P | Y | Y | Y | N | N | N |

LS P Y Y Y N N N
 Appendix D: Continued

| Position | Feelings | TT Aware -ness | POC Aware -ness | POC Office Name | TT Involve -ment | CRDA Involve -ment | TT CRDA Name |
|----------|----------|----------------------|-----------------------|-----------------------|------------------------|--------------------------|-----------------|
| LS | P | N | N | N | Y | N | N |
| LS | U | N | N | N | N | N | N |
| LS | P | Y | N | N | Y | N | N |
| LS | P | Y | N | N | N | N | N |
| LS | P | N | Y | Y | N | N | N |
| LS | P | N | N | N | N | N | N |
| LS | P | N | N | Y | N | N | N |
| LS | P | N | N | N | Y | N | Y |
| LS | P | N | Y | Y | N | N | N |
| LS | P | N | Y | N | N | N | N |
| LS | P | Y | N | N | N | N | N |
| LS | P | N | N | N | N | N | N |
| LS | P | Y | N | N | Y | Y | Y |
| LS | P | N | N | N | N | N | N |
| LS | P | N | Y | Y | N | Y | Y |
| LS | U | Y | Y | Y | N | N | N |
| LS | P | Y | Y | Y | N | Y | Y |
| Legal | P | Y | Y | | Y | Y | |
| Legal | P | Y | Y | Y | Y | Y | |
| Legal | P | Y | Y | Y | Y | Y | N |
| Legal | P | Y | Y | Y | | | |
| STT | P | Y | Y | Y | Y | Y | Y |
| STT | P | Y | Y | Y | Y | Y | Y |
| STT | P | Y | Y | Y | Y | Y | Y |
| STT | P | Y | Y | Y | Y | Y | na |
| STT | P | Y | Y | Y | Y | Y | Y |
| STT | P | Y | Y | Y | N | N | N |
| STT | P | Y | Y | Y | Y | N | Y |
| STT | P | Y | Y | Y | Y | N | Y |

Appendix D: Continued

| Position | General Comment |
|----------|--|
| CM | |
| CM | commercial mgmt needs to know if the govt is funding the TT |
| CM | is government funding tech transfer mechanism implementation |
| CM | emphasis to sponsor resr at univ could be combined with fed labs |
| CM | Has blanket agreement w/fed lab, very positive about CRDA work |
| CM | exclusive relationships with a company, that would spoil communication w/industry |
| CM | equal opportunity of access and limited funds available to do TT |
| ECON | evidence of great tech diffusion in process tech-labs need to impact process tech |
| LM | problem is TT process |
| LM | |
| LM | |
| LM | emphasis on collaborative efforts with consortia |
| LM | cultural differences and potential COI make this difficult |
| LM | company may not give lab credit for technology |
| LM | govt should devise system to encourage early industry role |
| LM | Govt funded TT effort for onsite personnel, 2 way street |
| LM | overclassification is an issue and lab motivation for TT |
| LM | need for correct mgmt attitude to allow staff to do this |
| LM | need for mechanism to solicit reverse proposals from industry |
| LM | |
| LM | lab needs mechanism to do TT as money gets tighter, lab is changing |
| LM | We've got to make an effort to do it, identify markets and applications |
| LM | its hard to quantify all aspects of TT |
| LM | very much in favor and this could help the low TT output from lab |
| LM | everybody wants to transfer tech, but nobody wants to pay for |
| LM | flaw in lab training, don't appreciate where work goes, no mentoring |
| LM | concern over lab sponsorship aspect and sponsors approval |
| LM | barriers to taking industrial money |
| LM | encouragement from govt is essential and from lab mgmt. |
| LM | general level of awareness of opportunities in lab is issue |
| LM | job desc-no, our lab resr is so focused, not much seems applicable |
| LM | unofficial cooperative efforts, enough contacts to do the right thing unofficially |
| LM | need to get people to think in terms of identifying potential tech and customers |

Appendix D: Continued

| Position | General Comment |
|----------|---|
| LM | difficulty in addressing CRDAs as part of lab strategy |
| LM | publicizing of lab tech and ideas isn't very successful |
| LS | biggest problem is wariness on both sides |
| LS | |
| LS | competing process at industry is a potential problem |
| LS | need fewer constraints and utility for industrial contacts |
| LS | none |
| LS | if the AF requires this, we have no time or money to do it |
| LS | awareness is a problem, conduct awareness meetings |
| LS | no TT in job Desc, lots of business opportunities, some potential |
| LS | job desc - No |
| LS | N |
| LS | even though frustrating, happiest part of my career-most rewarding |
| LS | job desc no |
| LS | job desc no |
| LS | if we (fed labs) are to survive, we need to do this (DT2) |
| LS | job desc-no, would be hard finding a co. doing same sort of work |
| LS | none |
| LS | job desc-no, we need to communicate perhaps via CBD |
| LS | don't know of any situations like that but seems would be of great benefit |
| LS | none |
| LS | key is getting word out to industry (marketing), need to reach industry |
| Legal | problems on copyright and in general govt ownership of tech |
| Legal | need a major PR effort, got to get out and let people know |
| Legal | CRDAs are the most important alternative to a procurement contract |
| Legal | concern over global company's gov tech ending up on ITARS |
| STT | each lab needs a multidisciplinary team- he has solutions |
| STT | dealing with differing priorities of lab and industry |
| STT | fed labs still have a big job to do concerning awareness |
| STT | proper integration of TT program will result in advantage to R&D from interaction |
| STT | distinction between patent attorney and contract attorney has impact on CRDAs |
| STT | temporary position for me- I'm not the right person to talk to |
| STT | now looking forward to really doing CRDAs |
| STT | the flexibility now at univ-lab negotiating is needed by fed labs with industry |