GUIDEBOOK for TECHNOLOGY TRANSFER MANAGERS

MOVING PUBLIC R&D TO THE MARKETPLACE

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PREFACE

This guidebook is based in large part on a document prepared as part of a technology transfer management effort by the U.S. Department of Energy, Geothermal Technology Division (DOE/GTD). That document was prepared by the Meridian Corporation under subcontract to Rockwell International Corporation. Since final submission of that document, the Meridian Corporation authors (Dr. Daniel J. Entingh, Clinton J. Andrews, and Deepak C. Kenkeremath) have worked with Dr. John E. Mock, Director, DOE/GTD, and Dr. F. Timothy Janis, to revise and expand the original document. Dr. Janis is Director of Technology Transfer at the Indianapolis Center for Advanced Research (ICFAR), Inc., which operates ARAC, a NASA-sponsored Industrial Applications Center.

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The statements, views and opinions expressed herein are exclusively those of the authors, and do not necessarily represent those of the U.S. Department of Energy, Meridian Corporation, or ICFAR.

CONTENTS

	PAGE
FOREWORD	xi
INTRODUCTION	xiii
1. AN ORIENTATION	1-1
2. SOME GENERAL CONSIDERATIONS	I-1
3. TECHNOLOGY TRANSFER TOOLS	3-1
4. AUDIENCES: SYSTEMS AND ACTORS	4-1
5. ASSESSING THE READINESS OF TECHNOLOGY FOR TRANSFER	5-1
6. SELECTING APPROPRIATE MECHANISMS	6-1
7. PROGRAM PLANNING AND MANAGEMENT	7-1
8. RESOURCE SELECTION	8-1
REFERENCES	R-1
INDEX	X-1

QUICK REFERENCE GUIDE

TOPIC	PAGE
<hr/>	
1.0 AN ORIENTATION	
<hr/>	
1. What is "Technology Transfer"?	1-2
2. What are the two main types of technology transfer programs?	1-4
3. Is the "Technology Utilization" outlook a radically different approach to technology transfer for Federal programs?	1-6
4. Why should the "Technology Transfer" function be a separate part of the "Technology Utilization" process or program?	1-8
<hr/>	
2.0 SOME GENERAL CONSIDERATIONS	
<hr/>	
1. What drives technology transfer?	2-2
2. What drives successful technology utilization?	2-4
3. Why does the Federal Government take an active role in technology transfer?	2-6
4. What are the main components in technology transfer systems?	2-8
5. Is there a best definition of the scope of technology transfer?	2-10
6. How are "market pull" and "technology push" related?	2-12
7. How does (or should) a technology transfer program proceed differently when "pulling" or "pushing" a technology?	2-14
8. What is "negative" technology transfer?	2-16
9. What aspects of technology transfer are most important to a "Technology Utilization" oriented program?	2-18
<hr/>	

TOPIC	PAGE
<hr/>	
3.0 TECHNOLOGY TRANSFER TOOLS	
<hr/>	
1. What are the main modes of technology transfer?	3-2
2. What are some of the effective mechanisms for technology transfer?	3-4
3. How can Federal incentives be applied to influence technology transfer and the technology delivery system?	3-6
4. What is the easiest way to determine when one mode and mechanism or another might be the most appropriate?	3-8
5. How does the Inventor view the process?	3-10
6. How does the Informer view the process?	3-12
7. How does the Innovator view the process?	3-14
8. How does the Integrator view the process?	3-16
9. How do these models fit together?	3-18
<hr/>	
4.0 AUDIENCES: SYSTEMS AND ACTORS	
<hr/>	
1. The "audience" of a technology transfer effort sometimes seems to be everybody. What are some good ways to decide which audiences to work with, and how to work with them?	4-2
2. How do I identify the important target audiences for technology transfer efforts?	4-4
3. Describe a generic "Technology Delivery System"	4-6
4. Show a typical "Technology Delivery System"	4-8
5. How do I develop a good picture of the "Technology Delivery System" for my technology?	4-10
6. How does understanding the "Technology Delivery System" affect what a technology transfer program does?	4-12
7. Describe other factors that are important in using the "Technology Delivery System" approach	4-14
8. Once I have detected whom to work with, how can I keep my interactions with these actors clear and simple?	4-16

TOPIC	PAGE
9. What are the typical needs of a "Technology Acquisition Agent?"	4-18
10. How can I best help a "Technology Acquisition Agent?"	4-20
11. How should I approach the process of selecting and packaging information for the target audiences, and interacting with them in other ways?	4-22

5.0 ASSESSING THE READINESS OF TECHNOLOGY FOR TRANSFER

1. At which stage of technology readiness must the technology transfer process begin?	5-2
2. What is transferred?	5-4
3. How are the information and devices used?	5-6
4. Are there statistics on how transferred technology is used?	5-8
5. What are some "secondary" uses of information gained through a technology transfer process?	5-10
6. How does one identify technology that might be ready for transfer?	5-12
7. What must a technology transfer manager do to assess the readiness of technologies for transfer?	5-14
8. What should be transferred at each stage of development?	5-16

6.0 SELECTING APPROPRIATE MECHANISMS

1. What should be considered when selecting technology transfer mechanisms in a "Technology Utilization" program?	6-2
2. Nature and Status of the Technology	6-4
3. Nature and Status of the Industry	6-6
4. External Economic Factors	6-8
5. Political Philosophy of Decision-Making and Perceived National Priorities	6-10

TOPIC	PAGE
6. Budgetary Constraints and Options	6-12
7. Nature of the Audience	6-14
8. Summary: A Matrix of Mechanisms' Appropriateness	6-16

7.0 PLANNING AND MANAGEMENT

1. Why is the planning process one of the most important tools of technology transfer management?	7-2
2. What are the organizational levels of management and planning typically required for effective technology transfer?	7-4
3. How do planning and management focus and tactics vary with technology delivery system characteristics?	7-6
4. Why is audience (client) participation important in planning technology transfer program activities?	7-8
5. What are the most essential aspects of monitoring and reporting progress from T.T. program operations?	7-10
6. What are the steps for planning a T.T. program?	7-12
7. What is strategic planning about, and how is it done?	7-14
8. What are some practical "steps" for strategic planning?	7-16
9. What must the T.T. Program manager consider in the tactical planning of a Technology Transfer effort?	7-18
10. What must the T.T. agent consider in the planning of an operational T.T. effort?	7-20
11. What must a Technology Transfer Program manager do to integrate many tactical T.T. efforts into a coherent whole?	7-22
12. Evaluation Check List	7-24
13. Technology Transfer Methods Checklists	7-26

8.0 INFORMATION RESOURCES

1. What is information?	8-2
-------------------------	-----

TOPIC	PAGE
2. How is information organized?	8-4
3. How is information accessed?	8-8
4. How does information impact the technology transfer process?	8-10
5. Resource Networks	8-12

FOREWORD

We are all aware of the increasing debate in the United States with respect to the competitiveness of U.S. industry and products in the global marketplace. A major portion of that debate has centered on what many believe to be our increasing inability to move technological innovations out of the laboratory and develop them into commercially viable products. There exists a long list of products in areas as diverse as computer science, energy technology, automotive design and consumer electronics where we have been unable to capitalize fully on the genius and inventiveness of our research and development community. The reasons for this are many, and involve all levels and sectors in the chain of invention and commercial reality. Ongoing press coverage of the current race to produce high temperature superconducting materials illustrates both the seriousness and visibility of our predicament.

A critical link in the process of bringing new innovations to the marketplace is the R&D manager. It is the R&D manager who "lives" with the research, who initiates and provides the much needed early push to successfully move those innovations into the hands of industry and ultimately the consumer. The R&D manager can have a significant impact on our ability as a Nation to get our innovations out of the lab and into the marketplace.

The United States government is the single largest sponsor of technology R&D. The managers of Federally funded research and development efforts have a special interest and explicit responsibility for ensuring timely transfer of technology to the private sector marketplace. Indeed the entire rationale for government sponsored non-military R&D is based on the premise of eventual commercial application of research results. As the stewards of projects undertaken for the public's benefit, they must ensure that real benefits result from Federal research investments. Often, this will occur only if conscious and concerted efforts are made to facilitate the technology transfer process.

Managing a successful public-to-private sector technology transfer program requires special enthusiasm, planning, and resources -- particularly within the constraints of government bureaucracy. It also requires specific knowledge of effective technology transfer strategies and methods. This publication provides these welcome details in a simple, straightforward question-and-answer format. I believe that this **Guidebook for Technology Transfer Managers** will be a valuable reference for anyone involved in the important process of moving technical advances out of the lab and into the marketplace. It is written not for the technology transfer theorist, but for the first level program manager who is interested in developing and implementing a successful technology transfer process. It demystifies jargon and suggests practical, common sense approaches. It summarizes a variety of strategies for accomplishing technology transfer and provides clear examples for readers to follow. It also contains an extensive set of checklists and glossaries for day-to-day use.

This guidebook will allow R&D managers to fulfill their increasingly important and highly visible roles in improving the competitiveness of U.S. technology in the world market. I highly recommend it to R&D managers as well as to decision-makers and implementors, in both the public and private sectors, as a standard reference guide.

-- Bruce Merrifield
Assistant Secretary for Productivity, Technology and Innovation
U.S. Department of Commerce

INTRODUCTION

Today is a time when technological advancement is vitally important to the U.S. and world economy. Federal research and development (R&D) and technology transfer (T.T.) activities play a vital role in this arena. They attempt to develop useful technologies and disseminate them to non-Federal actors who can use them effectively.

Technology transfer is rarely a simple process. Many actors with diverse outlooks and interests are involved. Matching new technologies to economic and socially acceptable roles within rapidly changing industrial and governmental infrastructures is a multi-dimensional task. Technology transfer is frequently underfunded. Its management is often conducted along unclear lines of responsibility and authority.

PURPOSE AND SCOPE

This Guidebook is intended as an introduction and refresher for Federal technology transfer managers. The focus is always the question: "What can the Technology Transfer manager do when confronted by particular confusing situations and events?"

The concepts and level of detail presented here fall somewhere between a "Primer" and a detailed "Handbook". The purpose is two-fold:

- * To introduce new technology transfer managers to some of the more useful concepts that have emerged in the T.T. field over the past 15 years, and
- * Remind seasoned managers of when some of these T.T. approaches and methods are most useful.

The selection of concepts was guided by the seminars and discussions at a three-day workshop, "A Synthesis of Technology Transfer Methodologies", convened by the Division of Geothermal and Hydropower Technologies, U.S. Department of Energy, in Washington D.C. in May 1984.

The main functional issues addressed here concern the conduct of technology transfer in "Technology Utilization" programs. These are R&D programs whose primary mission is to develop technologies that will be used outside of the Federal sector. Renewable energy systems and agricultural advances are technologies of this type.

Relatively little attention is devoted to "spin-off" to non-Federal sectors of technologies developed mainly for Federal use (e.g., military technology). And no attention has been devoted to the establishment and use of a national T.T. clearing house, an idea that has been recommended for more than twenty years by leading U.S. technologists and industrialists, but has never been implemented.

The contents of the Guidebook should be of value to managers in a variety of Federal and State technology development and transfer programs. The general area of transferring service innovations (e.g., for mental health and criminal justice) is not covered here. The Guidebook is primarily about the development and care of hardware.

The Guidebook makes no attempt to judge the value of specific technologies in meeting societal needs. Rather, it is addressed at the improvement of the technology transfer process itself. It does, however, include reminders that ascertainment of the social value of specific technologies is one of the important yet difficult tasks of R&D and T.T. programs.

ORGANIZATION

This book is organized around eight primary concepts that structure the eight major Sections. Each Section is headed by its own Table of Contents, and a short Guide to the functional roles of its subject matter.

The earlier Subsections of Sections 1.0 through 3.0, and Section 8.0 tend to be introductory. If you are reading this as a refresher, you might merely skim that material. Sections 4.0 through 7.0 contain progressively denser and more sophisticated material. Sections 6.0 and 7.0 are intended to be read relatively completely and carefully.

PRIMARY CONCEPTS

Section 1.0 - At its best, Technology Transfer (or "T.T.", as it is often abbreviated here) is an active process that deserves to be and can be managed actively, rather than reactively.

Section 2.0 - Technology Utilization programs require a different outlook on the T.T. process than do R&D programs that spin-off technology to non-Federal sectors. Some fundamental concepts (e.g., "technology push", and "negative technology transfer") are explained.

Section 3.0 - There is a wide variety of T.T. modes and mechanisms available to the T.T. manager. Every effective mechanism provides an incentive for a non-Federal actor to adopt a technology. The easiest way to select the most appropriate mechanisms is to consult directly with potential adopters. T.T. mechanisms must be sensitive to the different outlooks and interests of everyone involved in the R&D and T.T. process.

Section 4.0 - Audiences for T.T. efforts should be understood as both "systems" and individual actors. Technology adopting systems can be analyzed and influenced as "Technology Delivery Systems", comprised of organizations with varied specialized infrastructural roles. Individual actors can be best influenced by treating them as "Technology Acquisition Agents", who often need assistance in convincing their own organizations to invest in new technology. The most critical aspect of analyzing audiences is to identify the specific uncertainties about a technology that potential adopters need T.T. program assistance in resolving.

Section 5.0 - Some technologies are more ready for transfer than others. Some T.T. efforts should occur very early in the product's R&D life cycle, to keep potential adopters aware of and interested in what is coming down the road. The intensity and cost of T.T. often intensifies as a technology approaches commercial adoption.

Section 6.0 - Technology transfer program structure and mechanisms must be tailored to technology characteristics, Technology Delivery System characteristics, and to the current Federal and socio-political climate. This Section describes T.T. options that might be suitable for specific conditions and situations. The last Subsection provides a matrix of mechanisms that have been found suitable for meeting specific Technology Utilization Program objectives.

Section 7.0 - Effective planning, at both strategic and tactical levels, is the major management tool for T.T. programs. This Section describes a variety of planning functions and tools, and contains suggestive Checklists for strategic planning, tactical planning, operational planning at the T.T. agent level, T.T. program integration, and T.T. project and program evaluation. Section 7.13 is a list of the technology transfer mechanisms mentioned in this Guidebook.

Section 8.0 - Among the key ingredients of a successful technology transfer program are the generation, organization, accession and use of relevant information resources in a cost-effective manner. This Section defines information and the generation process, describes its organization and how to access it, indicates the utility of information in the technology transfer process, and highlights the organized systems for information resource identification.

At the end of the Guidebook there are References and an Index.

1.0 AN ORIENTATION

1. What is "Technology Transfer"?
 2. What are the two main types of technology transfer programs?
 3. Is the "Technology Utilization" outlook a radically different approach to technology transfer for DOE programs?
 4. Why should the "Technology Transfer" function be a separate part of the Technology Utilization process or program?
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GUIDE TO SECTION 1.0

Section 1.1 defines "Technology Transfer".

Sections 1.2 and 1.3 describe how technology transfer differs between R&D programs whose goal is to develop technology for private-sector use and R&D programs that "spin-off" technology developed primarily for Federal use.

Section 1.4 explains why technology transfer usually should be managed independently from other R&D program activities.

1.1 What is "Technology Transfer" ?

- A. It is a process that actively seeks to match peoples' expressed technical needs with newly available and applicable devices, methods, and data. Once a match occurs, it encourages the adoption and widespread use of that technology.**

It is very important to note that many technology transfer activities involve the transmission of information from one party to another, rather than the transfer of objects. The information can be about processes and procedures as well as about physical devices.

"People" includes firms in the private sector, officials at many levels of government, and, often, individual consumers. The people who might produce or use a new technology are often called "Potential Adopters" or "Target Audiences".

"Needs" range from elementary physical and social needs of individuals to complex problems in highly technical engineered systems.

"Transfer" comprises a large variety of mechanisms for moving a useful technical innovation from a research and development setting to a setting where the innovation can be produced to benefit many people. These mechanisms are described later.

"Technology" is used as a broad term that includes physical devices and production processes, and improved technical information and general services.

Technology Transfer includes almost every imaginable way of representing or communicating the essence of an improvement in a device or method. The communications involved in Technology Transfer work entail both "informing" and "convincing".

WHERE TECHNOLOGY TRANSFER FITS

1.2 What are the two main types of technology transfer programs?

- A. It is very important to differentiate "Technology Spin-Off" programs and "Technology Utilization" programs.

* Technology Spin-Off:

This is the "NASA-type" or "Department of Defense-type" technology transfer program. Some of the technology developed to serve an explicitly Federal mission is transferred to the private sector. The spunoff technology will be used for purposes other than those for which it was created. In this case, the principal mission of the agency can be achieved even if the agency's technology transfer function is completely ineffective.

* Technology Utilization:

This is the "Department of Energy-type" or "Department of Agriculture-type" technology transfer program. The mission of the agency is to create or improve technology primarily for use in the private sector. Any transferred technology will be used mostly for the purposes for which it was created. In this case, the principal mission of the agency will not be achieved unless its technology transfer activities are effective.

This distinction is especially important today because a great portion of the analytical literature on the effectiveness of technology transfer programs and methods is oriented to the NASA-type "spin-off" function. This outlook often emphasizes the centrality of the need-and-solution-matching process, and accordingly places importance on information dissemination and clearing-house techniques.

The manager of a DOE-like Technology Utilization program must realize that the "Spin-Off" orientation is an incomplete basis for managing a Technology Utilization program. Technology Utilization managers must configure all aspects of their R&D programs to ensure that the technology being developed meets real-world needs and can be fitted into the industrial and social infrastructure. In a very real sense, a "technology transfer" or "technology delivery" attitude must permeate all aspects of the program.

Even the way in which R&D projects are conducted must be sensitive to technology delivery considerations and requirements. For example, it is important to keep R&D workers in close contact with potential producers and users of the potential technology. And it is important to always keep R&D workers tracked toward the eventual commercial adoption of their concepts.

TWO TYPES OF TECHNOLOGY TRANSFER

TECHNOLOGY UTILIZATION PROGRAM

**A FEDERAL PROGRAM
CREATES TECHNOLOGY
TO MEET A NEED IN
THE PRIVATE SECTOR**

**MOST OF THE
DEVELOPED TECHNOLOGY
MUST BE
INTEGRATED INTO THE
PRIVATE SECTOR**

TECHNOLOGY SPIN-OFF PROGRAM

**A FEDERAL PROGRAM
CREATES TECHNOLOGY
TO MEET A
FEDERAL MISSION**

**SOME OF THE
DEVELOPED TECHNOLOGY
MAY BE
SPUN-OFF TO THE
PRIVATE SECTOR**

1.3 Is the "Technology Utilization" outlook a radically different approach to technology transfer than is currently employed for federal programs?

A. Yes and No.

We are advocating that the manager of a Technology Utilization program has to pay attention to quite different goals, events, and processes than a manager of a "spin-off" technology transfer program. Some of these differences are shown in the facing diagram.

Moreover, we believe that managing the technology transfer function of a Technology Utilization R&D program out of the "spin-off" orientation will make the program less effective than it could be.

However, there is nothing radically new about this insight. Many of the 1970's Federal analyses of technology transfer approaches came to this conclusion. This insight has always been implicit in our awareness that a "technology champion" is very important for successful innovation. And this point was raised repeatedly in the May/June 1984 DOE conference "A Synthesis of Technology Transfer Methodologies".

DIFFERENCES IN ORIENTATION

THE COMMON ORIENTATION: "SPIN-OFF"

A BETTER ORIENTATION: "TECHNOLOGY UTILIZATION"

- 1.4 If this more unified "Technology Utilization" outlook is better, why then should a "Technology Transfer" role or function be a separate part of the technology utilization process or program?

A. There are at least four reasons:

1. MODERATION of RISK: There are high costs and economic risk involved in matching and adapting technologies to needs. The technology transfer program can pay attention to "moderating" these risks, to gain economic or social benefits that otherwise would not obtain to the Government (or other institution) that sponsors the technology development, transfer, and utilization effort.
2. MEDIATION of INTERESTS: The fundamental interests of inventors, innovators, and adopters tend to be very different. The technology transfer program can "mediate" these interests by helping all parties better understand their common interests.
3. MODULATION of CAPABILITIES: The technical and communicative capabilities of innovators and adopters tend to be very different. The technology transfer program "modulates" these capabilities through information, education, and persuasion.
4. MANAGEMENT of ACTIVITIES: Momentary concerns of inventors, innovators, and adopters can prevent them from devoting clear attention to effective shared technology transfer strategies. The technology transfer program, if appropriately insulated from these daily concerns, can "manage" effective strategies and tactics for technology innovation and diffusion.

Performance tests, feasibility analyses, information dissemination efforts, and clearing houses address the "Moderation" issue.

Personal contacts, extension services, and technical assistance programs address the "Mediation" and "Modulation" issues. In some situations, Federal policy will bring financial or regulatory incentives into play here.

The ability to apply consistent attention and problem solving skills to "big-picture" and longer-term technology utilization issues and concerns is the key role of "Management" of the technology transfer function. If this role is to be handled well, it usually has to be split off from the more immediate concerns of a technology development and utilization program.

THE FUNCTIONS OF THE TECHNOLOGY TRANSFER PROGRAM

- * MODERATION OF INNOVATION RISKS**
- * MEDIATION OF INTERESTS AMONG INVENTORS,
INNOVATORS, AND ADOPTERS**
- * MODULATION OF CAPABILITIES AND COMMUNICATIONS**
- * MANAGEMENT OF STRATEGIC AND TACTICAL ACTIVITIES**

 

2.0 SOME GENERAL CONSIDERATIONS

1. What drives Technology Transfer?
 2. What drives successful Technology Utilization?
 3. Why does the Federal Government take an active role in technology transfer?
 4. What are the main components in Technology Transfer systems?
 5. Is there a best definition of the scope of Technology Transfer?
 6. How are "market pull" and "technology push" related?
 7. How does (or should) a technology transfer program proceed differently when "pulling" or "pushing" a technology?
 8. What is "negative" technology transfer?
 9. What aspects of Technology Transfer are most important to a Technology Utilization oriented program?
-

GUIDE to Section 2.0

Sections 2.1 through 2.3 describe the driving forces in technology transfer, and emphasize that active management of technology transfer is important.

Sections 2.4 and 2.5 define the scope of technology transfer in terms of actors and system goals.

Sections 2.6 and 2.7 define and describe the relationships of "market pull" and "technology push" in driving technology transfer events.

Section 2.8 defines "negative" technology transfer, which can be important to protect national and industrial security.

Section 2.9 defines the relationships among Sections 3.0 through 7.0.

2.1 What drives Technology Transfer?

- A. The driving force is a combination of (1) a need looking for a solution ("market pull") and (2) an improved product, process, or other technology looking for a market ("technology push").

In order to increase the socioeconomic benefits from Federally developed technologies, many programs support Technology Transfer agents. These agents work actively to facilitate matches between private sector needs and Federal R&D products.

This "facilitation" approach is adequate for "spin-off" technology transfer programs such as those at DOD and NASA, but it represents only the minimum effort needed for "technology utilization" programs such as those required by DOE. Federal Technology Utilization programs must and do manage the entire R&D process to ensure that the technology they develop will meet designated needs in economic and socially acceptable ways.

In its simplest form, technology transfer can occur in one of three ways:

1. A person with a need searches for and finds technology that will meet the need.
2. An inventor or other developer of a new technology searches for someone who can use it.
3. A third party, the technology transfer agent, aware of both the need and the technology, matches the two parties, and helps them complete their searches.

Much technical work is usually required after the "match" has occurred, in order to adapt the new technology to the user's specific needs. The Spin-Off technology transfer agent often contributes to the adaptation work.

THE TECHNOLOGY TRANSFER AGENT

2.2 What drives successful Technology Utilization?

- A. A person who serves as the "Champion" of the technology; i.e., a Technology Utilization Manager.

He or she is acutely aware of the need to understand and influence all aspects of the technology development and adoption process. This person plays the central role of integrating needs and solutions within the overall context of social, economic, and political factors.

The Technology Utilization Manager must interact with three important constituencies:

- o Persons with needs, who might become adopters of technological solutions to those needs
 - o Technology developers, especially scientists and engineers, who need guidance on what is needed or desired and what technology might meet those needs
 - o Many others who are affected by technology development and adoption processes, including:
 - National, state, and local politicians
 - Government program administrators
 - Potential investors and lenders
 - Potential opposers of the technology
-

THE TECHNOLOGY UTILIZATION MANAGER

2.3 Why does the Federal government take an active role in technology transfer? Aren't the "natural" tendencies to look for solutions to needs, and to find markets for better mousetraps, enough to drive the transfer process without third party assistance?

- A. The Federal government supports active technology transfer for a number of important reasons. Most of these are related to natural barriers to the flow of information between inventors and users.
-

Some of the established reasons for Federal involvement in technology transfer are:

1. The government often develops technology for specific purposes, and knows that the technology can be used for many other purposes. Components of space and defense systems (e.g., integrated circuits) are good examples of such technologies. Similarly, some components and materials developed for energy systems can be used in biomedical applications.
 2. Potential adopters often aren't aware of available technology. The information-processing required to match tens of thousands of valuable concepts with the varying needs of hundreds of thousands of firms (or many millions of consumer end users) is done most efficiently by a central clearing-house.
 3. Similarly, the work needed to evaluate the usefulness of new technology would otherwise have to be duplicated by many potential adopters, and technology developers would otherwise have to duplicate efforts to understand complex markets.
 4. People and firms often have "psychological" resistances to adopting new technology. Engineers sometimes feel they won't be rewarded for adopting licensed technology -- the "Not Invented Here" syndrome. Some firms may want to keep their production process shrouded in secrecy.
 5. Inventors and users often speak in different "tongues", and a third party is often necessary as an interpreter. Users are often focused on today's markets, while inventors are often focused on tomorrow's invention.
 6. Technology producers may not be able to capture a profitable share of the social benefit of a new technology. In such cases (e.g., the mechanical kidney), the technology may have to be subsidized if its benefits are to be obtained.
 7. For some technologies, the risks in adapting them for use are too great for individual firms to assume; therefore, part of this risk must be borne by the Government.
-

BARRIERS THAT TECHNOLOGY TRANSFER CAN SURMOUNT:

2.4 What are the main components in Technology Transfer systems?

A. The components are listed and defined below.

- 1. Technology:** Any physical or information-based representation of a concept, a process, a procedure, a functional physical device, or a consumable material or product.
 - 2. Inventor:** The person or firm who conceives of new technology and reduces it to practice.
 - 3. Innovator:** The person or firm who takes invented technology to its first commercial use, and is or uses the technical services of an "adapter" -- a person who makes market-oriented improvements in a technology.
 - 4. Innovation:** What the innovator does as process. Also used to denote the transfer of technology to its first adopter.
 - 5. Adopter:** A person or firm who uses technology that was developed by another. "Adopter" sometimes connotes the person or organizational function who decides that an invention or innovation will be used.
 - 6. Target Audience:** A group of potential adopters of technology that is addressed by a specific technology transfer effort.
 - 7. Technology Transfer Agent:** A person who matches inventors and their innovations to potential users, and assists the two parties in adapting an innovation to practical use.
 - 8. Technology Acquisition Agent:** A person who searches for new technology to satisfy a need. Many firms have developed this function highly as a separately managed activity, and routinely purchase or license technology from other firms. Other firms can benefit from assistance in this function.
 - 9. Product Champion:** A person who provides the managerial and entrepreneurial leadership to convert an invention into an innovation.
 - 10. Diffusion:** The spread of an innovation from its initial few adopters throughout a broad market.
 - 11. Information Flow:** The passage of knowledge about technology from one party to another. This plays a big role in technology transfer because many features of technology can be transferred as information, rather than as physical devices.
-

MAIN COMPONENTS

2.5 Is there a best definition of the scope of "Technology Transfer"?

- A. Probably not. Transfer agents and consulting analysts have come up with a wide variety of outlooks that seem to be important. It seems most important to recognize that:**
- 1) Technology transfer operates in the realm of creating linkages between people with needs and people with technological capabilities.**
 - 2) This must be done in different ways for different people and different technologies.**
-

SOME DEFINITIONS:

- * "Technology transfer" is information flow across the institutional boundaries of human activity.**
 - * "Technology transfer" is the transfer of research results to operational settings.**
 - * "Technology transfer" is the acceleration of application of R&D results to industrial settings.**
 - * "Technology transfer" occurs whenever systematic, rational knowledge developed by one group or institution is embodied by a way of doing things by other institutions or groups. (Dr. Harvey Brooks, Harvard University).**
 - * "Technology transfer" should include technical training and technical education.**
 - * "Technology transfer" can sometimes require the provision of substantial economic incentives by a government or other investor to reap future rewards from technologies that are not cost effective today.**
 - * "Technology transfer" must include consideration of the negative consequences of technology falling into the "wrong" hands.**
-

THE SCOPE OF TECHNOLOGY TRANSFER

THE UNIVERSE OF NEEDS

AREA WHERE TECHNOLOGIES COULD
MEET NEEDS

THE MILIEU OF
A SPECIFIC
TECHNOLOGY
UTILIZATION
PROGRAM

THE UNIVERSE OF TECHNOLOGY

2.6 How are "market pull" and "technology push" related?

- A. "Market pull" drives the technology transfer process when existing firms seek better technology to reduce their costs of production or to make marginal improvements in the quality of their existing products. In this case, a currently perceived "need" is the motivator for action. The market "pulls" technology into it. The gradual incorporation of micro-computers into automobiles and office machinery are good examples of market pull.

"Technology push" drives the technology transfer process when an innovator sees an opportunity to profit from a technology which has little or no current market. An "entirely new" market is created, based on the novel capacities of the technology. Technology "pushes" its way into the market economy. Xerox machines, Polaroid cameras, transistors, and integrated electronic circuits are oft cited examples of technology push.

There have been many arguments within the technology transfer analysis and management community as to whether "market pull" or "technology push" is the "dominant" force that drives technology transfer. The question is important because it affects the technology transfer agent's decision of whether to focus his attention on "needs" or on "technologies".

"Technology push" was a very important focus in the early 1960's, as federal technology transfer agents became aware that much electronics and materials ecology developed for defense and space uses could have broad application in the civilian economy. These technologies had to be "pushed" into firms that initially understood neither their economic potential nor how to work with the technologies themselves.

However, a number of studies done in the mid-1960's tend to suggest that "market pull" is the sine qua non of effective transfer. A real need for which there is no immediate solution will persist, but a technology that meets no real need will wither.

In recent years, a reconciliation between the "market pull" and "technology push" theories of technological dynamics has been attempted by Nelson and Winter, among others. They propose an essentially biological model organized around the concept of a "selection environment," in which the path of innovation is determined partly on the basis of technological tradition, partly by essentially "Darwinian" market forces, and partly by other non-market forces, i.e., government regulation. Like biological organisms, industries have "genes," or institutional routines to help them respond and adapt to a changing world. Functional technology transfer mechanisms are a vital subset of the routines used by successful industries in perpetuating their existence. "Push" and "pull" remain in the lexicon as valuable concepts to direct efforts at the practitioner level.

See Section 6.7(D) for more discussion of this issue.

PUSH AND PULL

TECHNOLOGY PUSH:

MARKET PULL:

2.7 How does (or should) a technology transfer program proceed differently when "pulling" or "pushing" a technology?

- A. The greatest difference lies in who will have to support or conduct the needs-and-technology matching process and the work to adapt technology to a specific need.

In the Technology Push situation, the innovator (the inventor, technology applications developer, or technical entrepreneur) must support such efforts, for he will profit from successful transfer through sales, license fees, etc.

In the Market Pull situation, adequate support for similar efforts will initially come only from a party who has a real interest in solving a problem or meeting a need.

Toward the end of successful transfer efforts, both the innovator and the need-satisfier will often be intimately involved in a collaboration to marry (adapt) the technology to the need.

The technology transfer program and its agents are likely to be influenced in their orientation by the source of their funding, i.e., whether their primary support comes from clients who enter with a need, or those who enter with a technical concept.

DIFFERENT FOCUSES FOR:

MARKET PULL ACTIVITIES:

- Understand Market Needs in Detail
- Search for Appropriate Technologies
- Confirm Technology's Applicability and Profitability
- Understand Technology Producers' Technical Needs and Capabilities
- Convince Someone to Produce the Technology in a Form Adapted to Specific Needs
- Manage the Adaptation Process
- Manage the Adoption Process

TECHNOLOGY PUSH ACTIVITIES:

- Understand the Immediate Capabilities of the Technology
 - Project the Future Capabilities of the Technology
 - Search for Real-World Uses and Markets for the Technology
 - Confirm Applicability and Profitability of Technology with Respect to a Specific Use
 - Convince User (and Producer) to Adopt Technology
 - Help Manage the Adaptation Process
 - Participate in the Adoption Process
-

2.8 What is "negative" technology transfer?

- A. Negative technology transfer is any effort that seeks to keep valuable technology from being acquired by a competitor or enemy.**

The concept of negative technology transfer is important to any innovative firm, for the firm must keep its trade secrets and economically valuable innovations from competitors.

Negative technology transfer has recently assumed new importance in U.S. dealings with foreign powers. The Departments of Defense and Commerce have intensified efforts to keep computers and other technology with potential military applications from being transferred to the Soviet Union. Moreover, there appears to be a consensus developing in the U.S. that American technology needs "negative transfer" to keep it from foreign economic competitors.

These trends have implications for managers of "positive" technology transfer programs, especially with respect to the need to be aware of export licensing requirements and procedures. In the longer term, national concerns about loss of technology to foreign competitors may lead to intra-U.S. restrictions on the degree of technical detail about highly innovative materials, devices, and procedures in the open literature.

POSITIVE AND NEGATIVE TECHNOLOGY

POSITIVE TECHNOLOGY TRANSFER

SEEKS TO PROMOTE ADVANTAGES TO:

- * U.S. Producers**
- * U.S. & Foreign
Technology Users**
- * National Economic
Strength**
- * National Security**

NEGATIVE TECHNOLOGY TRANSFER

SEEKS TO PREVENT ADVANTAGES TO:

- * Opponents' Military
Strength**
- * Opponents' Economic
Strength**
- * Non-U.S. Producers**

BUT CAN CAUSE DISADVANTAGES TO:

- * U.S. Producers of
Technology**
- * U.S. Innovators**
- * Foreign Technology
Users**
- * Friendly Governments**

2.9 What aspects of Technology Transfer are most important to the manager of a Technology Utilization oriented program?

A. The important factors are:

- * Understanding technology transfer methods well enough to integrate them into a system;**
 - * Understanding your R&D Program's potential adopter audiences as both systems and individual actors;**
 - * Discerning the readiness of technology for application to different uses;**
 - * Selecting appropriate technology transfer modes and mechanisms; and**
 - * Planning and managing the overall technology transfer program.**
-

THE CRITICAL FACTORS

TECHNOLOGY TRANSFER TOOLS

- Modes
- Mechanisms
- Processes and Models

AUDIENCES

- Technology Delivery System
- Technology Acquisition Agents

TECHNOLOGY READINESS AND USES

- How Technology Gets Used
- Monitoring Readiness

SELECTING APPROPRIATE MECHANIC MECHANISMS

- Contextual Factors
- Summary Matrix

TECHNOLOGY TRANSFER PROGRAM MANAGEMENT

- Strategic Planning
 - Tactical Planning
 - Evaluation
-

3.0 TECHNOLOGY TRANSFER TOOLS

1. What are the main modes of Technology Transfer?
 2. What are some of the effective mechanisms for Technology Transfer?
 3. How can Federal incentives be applied to influence technology transfer and the Technology Delivery System?
 4. What is the easiest way to determine when one mode and mechanism or another might be the most appropriate?
 5. How does the Inventor view the process?
 6. How does the Informer view the process?
 7. How does the Innovator view the process?
 8. How does the Integrator view the process?
 9. How do these models fit together?
-

GUIDE to Section 3.0

Section 3.1 describes Passive, Semi-Active, and Active modes of technology transfer.

Section 3.2 lists some of the effective mechanisms for technology transfer. Note that Section 6.0 is devoted entirely to how to select effective mechanisms. Section 7.13 provides the most complete list of mechanisms in this Guidebook.

Section 3.3 describes a special set of technology transfer mechanisms: Federal economic and regulatory incentives for technology adoption.

Sections 3.4 through 3.9 describe and integrate the view- points of various actors in the technology development and transfer process.

3.1 What are the main modes of Technology Transfer?

A. There are three main modes of technology transfer:

1. Passive Mode: The potential adopter of technology must search for suitable technologies by contacting R&D performers or examining archives of the results of R&D.
 2. Semi-Active Mode: A search facilitator or "transfer agent" is added to the system. This person helps users identify technical solutions, and sometimes has a capability to help evaluate technologies.
 3. Active Mode: A technology champion is added to the picture. The champion has the goal and capabilities to adapt technology to the needs of the potential users and sometimes to influence the market for the technology.
-

The passive mode is by the far the least expensive, and the least effective. It places most of the transfer work on the shoulders of the potential adopter. Another disadvantage of this mode is that it tends to keep the users and the R&D workers separated. It thus generates little useful feedback to the R&D program about the suitability of the technology being developed. Most "basic" R&D programs are forced to rely on this mode of technology transfer.

The semi-active mode is more expensive, but has the advantage of helping multiple potential users to avoid the costs of repeating the same search for technology. The transfer agents may have a substantial ability to evaluate the performance and economics of a new technology. This mode is the hallmark of spin-off technology transfer programs. NASA does it well, while the Department of Defense does it hardly at all.

The active mode is the most expensive, and the most effective. Here a person or small group of people take personal responsibility to see that a social need is met or a specific useful technology is adapted to a need or a market. These "technology champions" tend to interact with all players in the R&D, market, and regulatory/political arenas when necessary.

MODES OF TECHNOLOGY TRANSFER

PASSIVE MODE:

SEMI-ACTIVE MODE:

ACTIVE MODE:

3.2 What are some of the effective mechanisms for Technology Transfer?

- A. The facing page shows some of the technology transfer methods that have been found to work.**

While some of these methods rely on "impersonal" techniques like economic incentives or publication of information, you should note that most of these methods involve face-to-face communication.

Most transfer agents and managers believe that it is hands-on experience, and face-to-face communication that make the biggest difference in technology transfer effectiveness.

Different mechanisms are more appropriate at various stages in the overall technology development, adaptation, and diffusion process. Section 6.0 of this presentation makes suggestions for matching methods to conditions.

SOME TECHNOLOGY TRANSFER MECHANISMS

- * Intergovernment Agency Agreements
 - * Personnel Transfer to and from Industry
 - * Joint Government - Industry Development
 - * Government Development / Joint Test
 - * Tax Incentives / Loan Guarantees
 - * International Agreements
 - * Agreements with R&D Arm of Public Utility / Industry
 - * Technical Assistance / Education / Training
 - * Industry Technical Committees
 - * Workshops / Conferences / Seminars
 - * Technical Meetings / Exchanges
 - * Formal Visits
 - * Information Interactions
 - * Liason with Industry Associations
 - * Publications
 - * Information Dissemination Centers
 - * Data Banks
 - * Direct Mailing
 - * Media Announcements
 - * Patents
 - * Licensing
 - * Industrial Shows, Exhibits, and Trade Fairs
-

3.3 How can Federal incentives be applied to influence technology transfer and the Technology Delivery System?

- A. Federal incentives can be applied in many ways. Here's a list compiled by Arthur Ezra of the National Science Foundation.**
-

1. Federal Procurements and Price Supports

- a. Initial Federal Procurement of Limited Extent**
 - Intent is to get firm to manufacture new market-suitable technology, and then to sell it in the open market.
- b. Price Supports**
 - Are legitimate when there is high likelihood that they can drive product cost down a production learning curve rapidly, or when national security requires them.
 - Can fail expensively, e.g., Synfuels price supports.

2. Demonstration Projects and Information Dissemination

- a. Federally Funded Demonstration Projects**
 - The purpose is to provide empirical data on production cost, performance, reliability, and public acceptance.
 - Including a competent manufacturer in the project is essential for diffusion.
- b. Information Dissemination**
 - The necessary but not sufficient step to help adopters contact R&D performers.
 - Requires extensive translation work if done well.
 - The adopter incurs high expense in interpreting results.
- c. Subsidized Feasibility Analyses**
 - Addresses adopters' expense of interpreting results.
 - Vehicles include specific or general R&D contracts, and extension agents.

3. Construction Grants and Federal Patents and Licenses

- a. Construction Grants**
 - Can be given to industry if needed to support a specific R&D project or demonstration.
- b. Federal Patents and Licenses to Users**
 - Non-exclusive patents are sought by industry only if Federal R&D has removed most of the adaptation cost and risk.
 - There is a growing trend toward granting exclusive

patents to protect the firm's adaptation investment.

4. Federal Cost-Sharing and Leasing

- a. **Federal Cost-Sharing with Industry**
 - Industry interest helps justify program budget item.
 - But appropriate level of sharing is hard to evaluate.
- b. **No-Cost Leasing of Federal Demonstration Plants**
 - Was used frequently during World War Two to eliminate technical risk of expensive new plants.
- c. **Leasing of Public Sites and Minerals**
 - Lowers risk of technical innovator, e.g., for oil shale extraction tests.

5. Federal Testing, Performance Specifications, and Regulations

- a. **Government Testing of New Products and Processes**
 - A good incentive for consumer acceptance.
- b. **Publication of Government Specifications**
 - Helps standardize markets.
 - Has greatest effects when coupled with Federal procurement.
- c. **Federal Regulations**
 - Are powerful incentives, if based on results of accurate R&D regarding the feasibility and expense of regulatory technology.
- d. **Federally Funded Market Research and Testing**
 - Has been used to help commercialize potato flakes and a new type of fertilizer.
 - Could be used a great deal more than it has been.

6. Loan Guarantees and Loan Insurance

- a. **Loan Guarantees**
 - The intent is to raise the level of risk acceptable to lenders.
 - Since most guarantees cover only part of the loan, this intent often runs counter to the lender's normal prudence being applied to the non-guaranteed part of the loan.
 - b. **Loan Insurance**
 - Can provide greater long-term leverage for somewhat higher initial Federal cost.
-

3.4 What's the easiest way to determine when one mode and mechanism or another might be the most appropriate?

- A.** You can do this by viewing the overall process of technology transfer as a set of four interrelated feed-back loops or models of the technology development and diffusion process. These models, developed by Granville Hough, are explained in the next few pages.
-

Each of the models depicts the technology transfer process from the point of view of a different actor in a technology development program.

In simple cases, use of a single one of these models may be sufficient for designing and managing the transfer program. But in more difficult (and more typical) cases, all of the models will have to be used, and will have to be closely coupled together.

CONCEPTUAL MODELS

- **THE INVENTING MODEL**

- **THE INFORMING MODEL**

- **THE INNOVATING MODEL**

- **THE INTEGRATING MODEL**

- **TOTAL TECHNOLOGY TRANSFER PROCESS**

3.5 How does the Inventor view the process?

- A. The Inventing Model, like each of the other three models, is a production process with a feedback loop. The actor or his manager compares the actual output with the model's predicted output. If the match is favorable, they go to market. If it is not, they go back and modify the inputs or processing until they achieve a product or process with which they are satisfied.

The essential feed-back in this case is: "Does the technology performance meet a technical goal of the mission?"

The Inventing Model can be the only model used in the technology development and utilization process when:

- * It is known that meeting the technical goal will satisfy the real market or social need, and
- * The potential adopters are, on their own, tracking the development of the technology and are certain to adopt it as soon as the technical goals are met.

These conditions are most often met during a firm's internal improvement of an existing production device or process. They are rarely met when the new technology has to be marketed.

INVENTING (APPLIED RESEARCH AND DEVELOPMENT) MODEL

Source: Hough, G.W., Technology Diffusion, Lomond Publications, Mt. Airy MD, 1975
(2nd printing 1983) Chapter II

3.6 How does the Informer view the process?

- A. The Informing Model concentrates on the problem of communicating to the target audience that a new, useful technology exists. The audience must be informed, e.g. through broadcast advertising.**

The audience must also be convinced of the technology's value, usually through some form of demonstration -- whether it be by a sales person, a neighbor, or a government agency.

The Informing Model is adequate when the new technology requires no further adaptation to fulfill a market or social need.

The attention to the feedback loop in this case is absolutely essential. And the requisite feedback is "Are people buying/using this technology?" The use of "process" measures (e.g., column inches of newsprint) will not satisfy this requirement.

INFORMING (INFORMATION TRANSFER) MODEL

Source: Hough, G.W., Technology Diffusion, Lomond Publications, Mt. Airy MD, 1975
(2nd printing 1983) Chapter II

3.7 How does the Innovator view the process?

- A. The Innovator is the person who succeeds in making the very first real sales of the technology. His work usually consists of:
1. Altering a prototype technology to the point where it is acceptable to one or more customers, and
 2. Transferring the adapted technology from the development laboratory to the production and market environments.

The Innovator usually requires substantial business experience. She/he must understand the technology well enough to be firmly convinced of its potential, and to be able to convince others (e.g., financiers) of the potential.

Innovation rarely succeeds unless it is coupled with continued Inventing -- to perform final essential technical adaptations, and with continuous Informing -- both to prepare the market for the advent of the technology and to accumulate the resources needed for the final phases of the innovation.

Getting feedback in this case is often a very frustrating experience. A very long series of complaints on the order of "It doesn't work!" and "I don't like it!" can precede the first sale.

INNOVATING (APPLICATION) MODEL

Source: Hough, G.W., Technology Diffusion, Lomond Publications, Mt. Airy MD, 1975
(2nd printing 1983) Chapter II

3.8 How does the Integrator view the process?

- A. The Integrator is the person who diffuses the technology, after its first adoption. This individual adapts it to new sectors of the economic and social structure.

He or she, of all these four types of technology transfer agents, tends to remain most acutely aware that every adoption of a novel technology by a new sector, firm, or person, tends to be viewed by every new adopter as a full-fledged Innovating, Informing, or even Inventing process.

The process of encouraging others to imitate a previous Innovator plays a major role in the Integrator's task.

Of these four models, the Integrating model is the process where one must remain most acutely aware of interactions among various components of the economy and social order. The Integrator is often interested in long-term effects, e.g., developing a large photovoltaic power industry. To achieve this the Integrator must understand the current order of things and people, and how this order can be changed gradually.

THE INTEGRATING (DIFFUSION) MODEL

Source: Hough, G.W., Technology Diffusion, Lomond Publications, Mt. Airy MD, 1975
(2nd printing 1983) Chapter II

3.9 How do these models fit together?

- A. The facing diagram portrays a sense of how the four models interact.**

Each model at times needs to reach into, or use, each of the others in order to be wholly effective. And there are "macro" feedback loops -- not shown -- from the bottom of the page to the top, as both technology and society change.

Consideration of these models permits the identification of some of the technology transfer modes and mechanisms that are relevant as technology development progresses.

The models also help make it clearer that the goals and objectives of any technology transfer program tend to present themselves as moving targets. Technological, cultural, economic and social factors interact to provide a dynamic, rather than static context for technology transfer.

OVERALL TECHNOLOGY DIFFUSION PROCESS

Legend: — — — Secondary; ————— Primary

Source: Hough, G.W., Technology Diffusion, Lomond Publications, Mt. Airy MD, 1975 (2nd printing 1983) Chapter II

4.0 AUDIENCES: SYSTEMS AND ACTORS

1. The "audience" of a technology transfer effort sometimes seems to be everybody. What are some good ways to decide which audiences to work with, and how to work with them?
 2. How do I identify the important target audiences for technology transfer efforts?
 3. Describe a generic Technology Delivery System.
 4. Show a typical Technology Delivery System.
 5. How do I develop a good picture of the Technology Delivery System for my technology?
 6. How does understanding the Technology Delivery System affect what a technology transfer program does?
 7. Describe other factors that are important in using the Technology Delivery System approach.
 8. Once I have detected whom to work with, how can I keep my interactions with these actors clear and simple?
 9. What are the typical needs of a Technology Acquisition Agent?
 10. How can I best help a Technology Acquisition Agent?
 11. How should I approach the process of selecting and packaging information for the target audiences, and interacting with them in other ways?
-

GUIDE to Section 4.0

Section 4.1 distinguishes audiences as "systems" and "actors".

"Systems" are treated in Sections 4.2 through 4.7, as "Technology Delivery Systems" that can be influenced and improved by technology transfer efforts.

"Actors" are described in Sections 4.8 through 4.10, as "Technology Acquisition Agents".

Section 4.11, a pivotal section, describes the five major uncertainties of technology adopters that can be resolved by information about technology and markets.

4.1 The "audience" of a technology transfer effort sometimes seems to be everybody. What are some good ways to decide which audiences to work with, and how to work with them?

A. It is very useful to understand audiences in two ways:

- * Audiences as "Systems"
- * Audiences as "Actors"

The technology transfer agent perceives audiences as "Systems" when he is assessing the types of organizations or individuals that must become committed to an innovation if that innovation is to flourish. From this perspective the technology transfer target audiences are a very mixed set of industries, government agencies, consumers, and other organizations. Inter-organizational agreements and behaviors will be affected by technology transfer efforts. For example, lenders may have to develop new relationships with electric utilities and utility commissions to participate in financing home-owner energy conservation projects.

When considered as "Actors", each individual participant in a technology transfer/acquisition effort is embedded in a complex mix of capabilities and responsibilities within his organization. Informative and persuasive communication require that the technology transfer program tailor its approaches and methods to the information and decision-oriented needs of specific types of actors (e.g., executives, engineers, economists) and even specific individual actors.

**EXAMPLE: COGENERATION TECHNOLOGY
AUDIENCES AS "SYSTEMS" AND "ACTORS"**

4.2 How do I identify the important target audiences for technology transfer efforts?

- A. You must identify and understand the "Technology Delivery System" for the technology you want to transfer.**

Most Federal technology R&D programs operate in a specific technology area. The area may range from a specific technical discipline (e.g., "improve ceramic materials") to a broad societal need (e.g., "improve the U.S. housing stock").

If the technology developed by the R&D program is economically useful and socially attractive, it will eventually be moved into the economy through a network of private sector organizations. This network, along with the flows of technology, physical resources, information, and money through the network, can be viewed as a Technology Delivery System, or "TDS". There is a different TDS for almost every technology being developed by a Federal program.

Every organization in the TDS is embedded in a complex web of relationships with its customers, suppliers, financiers, and regulators. All parts of the TDS must interact efficiently if a new technology is to achieve diffusion. Moreover, for highly innovative technologies, some important components of its eventual TDS may not even exist during early phases of R&D.

Within each institution different individuals and groups have different interests and decision-making power with respect to the adoption of new technology. These decision makers will be affected differently by information, persuasion, and socio-economic incentives.

Successful technology utilization and technology transfer managers develop an acute understanding of component or "missing" organizations in their technology's TDS. They then apply information, persuasion, and/or various incentives to foster smooth integration of the TDS.

The concept of the Technology Delivery System has been most highly developed by Arthur Ezra, of the U.S. National Science Foundation. It is a way to identify, depict, analyze, and understand the diverse interests and needs of all actors who play key roles in the technology transfer and adoption process.

The next few pages explain what a TDS is, how to understand the TDS upon which your program depends, and how to interact with components of the TDS. This is the "Audiences as Systems" approach.

THE "TDS"

4.3 Describe a generic Technology Delivery System.

- A. The facing diagram shows two-dimensional chart representations of three TDSs of differing complexity.

The boxes represent the critical actors in technology transfer. The arrows represent flows of goods, information, and money among the actors.

What you must understand about the TDS for your technology are:

- * Who the primary actors are
- * What flows between actors
- * What are the few most important bottlenecks in those flows.

HORSESHOES represent a very simple case. All important transactions occur directly between the blacksmith ("technology producer") and the horse owner ("technology consumer"). Local gossip about the quality of the blacksmith's work, not shown, could be viewed as an important evaluative feedback path.

RAILROAD BOXCARS represent a case of moderate complexity. Here a few manufacturing firms produce boxcars sold to a few dozen railroads. The technology is complex enough that the producer might have to interact with the railroad's locomotive service shop or other servicers. Financiers can have direct interests in boxcar quality because these expensive capital items are part of the railroad's collateral base.

The TDS for **SOLAR WATER HEATERS** is even more complex. A large number of different local and national-scale actors must interact to develop a mixed manufacturing and service system that produces confidence among a very diverse developer and home-owner market base. The TDS for solar water heaters is in fact much more complex than that shown here. Government financial incentives, competition among utilities, and government regulation of technology (e.g., energy efficiency standards) and of energy systems (e.g., State PUCs) all affect how goods, information, and money flow through the TDS.

LEVELS OF COMPLEXITY IN TDS

1. HORSESHOES

2. RAILROAD BOXCARS

3. SOLAR WATER HEATERS

4.4 Show a typical Technology Delivery System.

- A. One conception of the U.S. geothermal energy Technology Delivery System is shown here.**

This conception emphasizes the energy conversion and end-use aspect of the geothermal energy TDS. An equally complex set of actors comprises the "Geothermal Field Development Subsystem" component, the top left box in the diagram.

It is important to note that:

- * Technology developed by the DOE Geothermal program tends to enter the TDS via assessments conducted by power conversion engineers. They play a key role in interpreting the value of new technology.
- * Technology, construed in the narrow sense of devices and technical information, is only one of a number of factors that dominate whether or not new technology is used. Economics and social expectations are equally important.
- * The ultimate beneficiary of this technology, the energy end user, may never know that the technology exists.

Since its inception in 1974, the U.S. Geothermal Energy Program has interacted quite directly with every kind of actor shown here. Some examples are:

- * Cooperative research with geothermal field developers and equipment suppliers to improve exploration, drilling, and production methods.
 - * Cooperative research with and handbooks for power conversion engineers to improve materials, components, and system performance and to reduce costs.
 - * Projects with electric utilities to develop technology to control release of substances to the air, water, and land.
 - * Provision of loan guarantees for field development and power plant construction, to help financiers learn how to establish effective lending relationships for this technology.
 - * Supporting local governments in planning and environmental studies to help citizens understand the social benefits and risks of geothermal energy systems.
-

GEOHERMAL ENERGY TDS

4.5 How do I develop a good picture of the Technology Delivery System for my technology?

- A. This is a matter of developing a general understanding of how industry adopts technology, with respect to both the technology (e.g., device) production role and the technology consumption role.**

There appear to be two main factors to consider here:

- 1. You have to detect who in the private sector makes the major decisions about adopting new technology, and then learn both how those decisions are made and how to influence them.**
- 2. You must be aware that a real-world TDS is a "moving target", in two ways:**
 - (a) Most industries change continuously.**
 - (b) The Technology Utilization Program might have to try to alter the real-world TDS in order for the technology to be delivered effectively.**

Perhaps the most important process is to identify organizations in the private sector who could individually benefit from providing and/or using the technology.

You have to map out both the current TDS and the TDS you believe would be effective in delivering the technology. If these are distinctly different, you will have to design interventions that will help the TDS evolve in the desired directions.

Some useful approaches:

- 1. Consult with those already in the business, to find their interaction paths (information, technology, and money), and the current bottlenecks in interactions.**
 - 2. Model gaps in the current TDS by analogy with effective processes in similar industries.**
 - 3. Do some "future casting" to envision what the elements of a growing or nearly mature industry might be. Use this to develop an understanding of what new technical and business centers might be needed, and to assess current education and training needs.**
-

SOURCES OF TDS INFORMATION AND INSIGHT

- * Interview and Re-interview Industry Managers
- * Treat Industry Like the Congress: Be Very Responsive To and Follow Up on Requests for Information
- * Involve Everyone in your Program in Efforts to Describe the TDS and Envisioning Improvements
- * Join and Participate in All Major Industry Associations
- * Conduct Frequent Interviews / Surveys of Industry
- * Pay Close Attention to Reports about Trends and Exceptional Events from Technology Transfer Agents and Extension Agents
- * Conduct Frequent Technical / Economic Workshops for Industry, and Learn Why People and Firms are Attending

4.6 How does understanding the Technology Delivery System affect what a technology transfer program does?

A. The program's evolving understanding of its TDS helps it to detect and assess:

- * Who needs specific kinds of technical information
- * Which industries might be willing to expand their markets into a new technology
- * What communication channels must be strengthened or created among industry subsectors
- * Where technical or financial capabilities might need to be strengthened to reduce a critical bottleneck in technology adaptation, production, or end use.

SOME EXAMPLES OF TARGETED INTERVENTIONS INTO PART OF A TDS:

(See Exhibit for Numbered Keys)

1. TT program collects and repackages system cost analyses for existing drilling devices.
 2. TT program helps design engineers gain access to information on drillability of particular geological formations.
 3. TT program serves as the information repository and clearinghouse for detailed technical information on interactions of geothermal brines with specific industrial materials.
 4. TT program helps manufacturers of tubular goods gain access to data on performance of products in various applications.
 5. TT program cost-shares project to develop a well-design optimization computer code.
 6. TT program holds symposium of drillers and engineers to collect evolving "rules of thumb" for well design.
 7. TT program helps design engineers understand economics of geothermal energy conversion systems, so that fluid economic values and design well flow rates can be established.
 8. TT program helps establish a new standards development group in an engineering professional association to specify well testing procedures and measurements that conform to the needs of field owners, power plant designers, and financiers.
-

INTERVENTIONS IN THE TDS

4.7 Describe other factors that are important in using the Technology Delivery System approach.

A. These four factors seem key:

1. YOU CAN INFLUENCE AND IMPROVE THE TDS
MAINLY THROUGH PROVIDING INCENTIVES

Some major incentives are: information, training, money, and constituency building. Some incentives simply fill in gaps in knowledge and capability on the part of existing actors. Other incentives are designed to influence the "mixed" American economy. Review the list of incentives at Question 3.3.

2. OIL THE SQUEAKY WHEEL

Stay in touch with, and try to satisfy by any legal means, qualified major decision makers in both industry and government. Especially, find the non-Federal actors who profit from decisions they make and are willing to pay for or be influenced by evaluative information.

3. USE MANY METHODS TO IDENTIFY AND QUALIFY
TARGET AUDIENCES

Some methods not mentioned above are:

- * Conduct patent reviews
 - * Advertise
 - * Sponsor Federal internships at Labs and Headquarters
 - * Maintain close liaison with relevant members of Congress.
-

4. DON'T IGNORE "SECONDARY" AUDIENCES

These include:

- * Financiers
 - * Technology evaluators and recommendors
 - * Standards laboratories
 - * Regulatory agencies
 - * Special interest groups including potential opponents.
-

FOUR KEY FACTORS

4.8 Once I have detected whom to work with, how can I keep my interactions with these actors clear and simple?

- A. The way to keep your interactions focused is to understand that most technology-oriented organizations include one or more people who play the role of "Technology Acquisition Agent". Find these people, and work to meet their needs with respect to fitting "your" technology into their systems.

The Technology Acquisition Agent is the private sector counterpart of the Federal "Technology Transfer Agent". He or she is seeking the technology that you are pushing.

In the past twenty years, some U.S. firms have become quite sophisticated in acquiring technology developed outside of the firm. Some of these firms have elevated Technology Acquisition Agents (by whatever name) to a status equivalent to that of the head internal R&D manager.

The advantages of technology acquisition are at least three:

- * A firm may be able to identify and purchase a technology "solution" within a very short time after a problem has surfaced.
- * A firm may be able to purchase the license to a technology for much less than it would have had to pay to develop the technology, even when the development path has low risk.
- * A firm may be able to purchase a high-development-risk technology after another firm has invented and partially developed it. This allows the purchasing firm to avoid certain significant risks.

Many observers have noted Japan's very successful use of technology acquisition since World War II.

You will "transfer technology" successfully if you identify your counterpart technology acquisition agents, and direct your work with them toward meeting their needs for evaluating technology and persuading others in their firms that it is worth adopting.

ACQUISITION AND TRANSFER

4.9 What are the typical needs of a Technology Acquisition Agent?

- A. See the facing diagram from the Harvard Business Review of December 1971.**

The agent, just like any other potential technology adopter, has to match technologies with needs or opportunities, and evaluate the quality or usefulness of the match.

In the "large" corporate environment, he further has to:

- * Analyze the economics of the technology
- * Analyze its market value and penetration
- * Plan the further adaptation of the technology
- * Perhaps even develop the prototype and make initial sales.

The technology transfer agent can support the technology acquisition agent in all these roles.

The Technology Acquisition Agent's role is developed to different degrees in different organizations. Some firms are still laggards with respect to innovation in general, and others still have a large dose of the "Not Invented Here" barrier to outside inventions.

The technology transfer agent of a technology utilization program must be ready to note instances of under-developed technology acquisition skills. In such cases, the technology transfer program must use training approaches to improve the firm's technology acquisition awareness, interest, and capabilities.

TECHNOLOGY ACQUISITION PROCESS

Reprinted by permission of the Harvard Business Review. An exhibit from "Organized for Technology Transfer" by Richard N. Foster (November /December 1971). Copyright © 1971 by the President and Fellows of Harvard College; all rights reserved.

4.10 How can I best help a Technology Acquisition Agent?

- A. Get the agent to tell you what is needed to inform and convince people in his or her organization about the value of your technology. Then, tailor your assistance to match what is requested.**

You and the agent can learn a lot from each other, especially since you play almost mirror image roles in the technology transfer process.

HOW TO WORK WITH THE TECHNOLOGY ACQUISITION AGENT

- * USE INFORMATION TO REDUCE SPECIFIC USER UNCERTAINTIES:**
 - The critical uncertainties are explained in the next section
 - * DON'T OVERLOAD THE ACQUIRER'S CAPACITY TO ABSORB INFORMATION:**
 - Retain the technology/need matching function within your R&D program
 - * TAKE AN ACTIVE POSITION:**
 - Communicate to persuade as much as to inform
 - * ENSURE ECONOMIC BENEFITS ARE CAPTURABLE BY THE ADOPTER:**
 - Use ultra-high care on patents and licenses
 - * PACKAGE INFORMATION TO HELP THE ADOPTER MEET HIS OR HER DUTIES:**
 - The adopter knows whom has to be convinced
 - help him or her do it
 - * BUILD ACQUISITION SAVVY THROUGH TRAINING:**
 - Effective acquisition skills can be taught and learned
-

WAYS TO ASSIST THE ACQUISITION AGENT

4.11 How should I approach the process of selecting and packaging information for the target audiences, and interacting with them in other ways?

- A. Approach this mainly from the viewpoint of reducing the audiences' specific "uncertainties" about the technology. The 1976 RAND study "Analysis of Federally Funded Demonstration Projects", found that one of the more important purposes of such projects is to reduce the uncertainties of non-Federal decision makers about the general appropriateness and the economics of new technology. The results of the RAND study are equally applicable to "pre-demonstration" stages of technology transfer.**

RAND found that potential adopters of technology can be viewed as having five broad types of uncertainties about the technology. These are described on the facing page.

In terms of information theory, "uncertainty" is the scientific inverse of "information". Detecting and understanding the potential adopters' generic and specific uncertainties about the value of a technology, will lead you fairly directly to knowing what information they need, and how to package it.

This analysis, and the insights that flow from it, is the most important analysis you can do as a T.T. manager. It will require lots of face-to-face inputs from both the audiences and the R&D management and staff. It must be updated periodically.

The overall design of the Technology Transfer function must flow from this final aspect of understanding both the Technology Delivery System and the needs of Technology Acquisition Agents.

This outlook is important enough that you might wish to make it a standard part of your annual program review. Useful focus questions are:

- * Is our R&D in general designed to reduce the most important uncertainties for this Technology Delivery System?**
 - * Are we communicating our new information in a way that reduces the real uncertainties of specific Technology Acquisition Agents?**
-

THE USER'S FIVE MAJOR UNCERTAINTIES

*** TECHNICAL READINESS**

- Performance: How well does this Technology work?
- Reliability: How Reliable is it?
- How Much Will the Technology Have to be Improved Before it is Acceptable in the Market Place?

*** COST**

- What are the Current Costs?
- Life Cycle Cost?
- Learning Curve Effects?

*** DEMAND**

- How Large is the Market, at These Costs?
- What are the Non-Market Economic Benefits?
- Can we Capture a Reasonable Share of the Overall Economic Benefits of the Technology?

*** INSTITUTIONAL FACTORS**

- How Will this Technology Fit into my Organization?
- How Will this Technology Affect our Interactions with Others?

*** EXTERNALITIES**

- What are the Non-Economic Risks?
 - What are the Non-Economic Benefits?
 - How does this Technology Fit Into into the Current Business Cycle?
-

THE UNITED STATES OF AMERICA

IN SENATE
January 10, 1947

REPORT OF THE

COMMISSION ON THE ORGANIZATION AND
ADMINISTRATION OF THE

EXECUTIVE BRANCH

OF THE UNITED STATES

DEPARTMENT OF THE INTERIOR

AND

DEPARTMENT OF AGRICULTURE

AND

DEPARTMENT OF COMMERCE

AND

DEPARTMENT OF LABOR

AND

DEPARTMENT OF JUSTICE

AND

DEPARTMENT OF NAVY

AND

DEPARTMENT OF WAR

AND

DEPARTMENT OF THE ARMY

AND

DEPARTMENT OF THE AIR FORCE

AND

DEPARTMENT OF THE COAST AND GEODETIC SURVEY

AND

DEPARTMENT OF THE NAVY

5.0 ASSESSING THE READINESS OF TECHNOLOGY FOR TRANSFER

1. At which stage of technology readiness must the technology transfer process begin?
 2. What is transferred?
 3. How are the information and devices used?
 4. Are there statistics on how transferred technology is used?
 5. What are some "secondary" uses of information gained through a technology transfer process?
 6. How does one identify technology that might be ready for transfer?
 7. What must a technology transfer manager do to assess the readiness of technologies for transfer?
 8. What should be transferred at each stage of development?
-

GUIDE to Section 5.0

Sections 5.1 through 5.3 describe why technology transfer must be begun early in the R&D process, and the diverse types of information that are involved in transfer efforts.

Sections 5.4 and 5.5 describe uses to which technology and information about it are put.

Sections 5.6 through 5.8 outline a process for assessing the readiness of technology for transfer.

5.1 At which stage of technology readiness must the technology transfer process begin?

A. From the very beginning of the R&D.

There are many reasons for this:

- * The technology being developed must be able to fit into its adoptive climate. It must be continuously targeted to known needs and adopter characteristics.
- * The lead times to develop technology are often notoriously long. This is due in part to failure on the part of inventors to work closely with market-oriented persons from early in the invention process.
- * The program manager's tenure is often shorter than the lag times. He must be continuous champion of his most promising technologies, even those at very early stages of development.

Technology adoption times can, however, be markedly reduced. Some examples from the DOE geothermal energy R&D program are:

1. Adaptation of General Electric synthetic diamond cutters into geothermal drill bits -- 5 years
 2. Adaptation of Sandia high temperature electronics into deep well logging tools -- 3 years
 3. Adaptation of high temperature O-Rings into geothermal drilling equipment -- 2 years
-

INNOVATION'S PACE

<u>TECHNOLOGY</u>	<u>START OF DEVELOPMENT</u>	<u>YEAR OF REALIZATION</u>	<u>DURATION, YEARS</u>
HEART PACEMAKER	1928	1960	32
INPUT-OUTPUT ANALYSIS	1936	1964	28
HYBRID CORN	1908	1933	25
ELECTRO PHOTOGRAPHY	1937	1959	22
MAGNETIC FERRITES	1933	1955	22
TRANSISTORS	1940	1950	10
ORAL CONTRACEPTIVES	1951	1960	9
VIDEO TAPE RECORDER	1950	1956	6

5.2 What is transferred?

A. Four useful categories to remember are:

- 1) Information or Data
- 2) Capability or Skill
- 3) Process or Method, and
- 4) Product/Device or Model.

-
- * **INFORMATION or DATA:** Printed words, graphs, tables, pictures, or descriptions often in the form of specifications, blueprints, test results, or computer media. These data can describe both static and dynamic conditions.
 - * **CAPABILITY or SKILL:** A personal ability to apply technology described by information or data to a particular situation. This can involve transfer of people from one laboratory to another.
 - * **PROCESS or METHOD:** A way to make or modify materials, phenomena, or information. The process, often dynamic in nature, incorporates both of the above two types of transfer.
 - * **PRODUCT/DEVICE or MODEL:** A typical breadboard, prototype, or device that is transferred from applied research to the product/process development laboratory.
-

THE SCOPE OF "TECHNOLOGY"

5.3 How are the information and devices used?

A. There are four major business functions whose conduct is affected by innovations:

- 1) Inputs
- 2) Processes
- 3) Saleable Products
- 4) Market Definition

-
- * **INPUTS:** The physical substances, energy, and general information that a business needs to operate its processes and to produce its products. Innovations can alter the raw materials used, or the rate of production.
 - * **PROCESSES:** The physical or informational methods by which the firm converts its inputs to products. Innovations can alter process definition, machinery, control, etc.
 - * **PRODUCTS:** The devices or services that a firm sells. Innovations can alter product function, components, configuration, quality, etc. Current products, or new product definitions can be affected.
 - * **MARKETS:** The perceived and actual markets for the firm's current and new products. Transferred information can affect the behavior of both the seller and the buyer. Technology transfer programs often interact with both producers and consumers in a "brokering" role.
-

WHERE TECHNOLOGY IS USED

→ INFORMATION FLOW

→ PHYSICAL FLOW

5.4 Are there statistics on how transferred technology is used?

A. Yes. Here's an example.

An analysis of a few hundred cases where firms were actively considering use of NASA technology in the early 1960's found that firms incorporated new technology in the following ways:

<u>% OF CASES</u>	<u>POTENTIAL FUNCTION OF NEW TECHNOLOGY</u>
32	Incorporate an improvement into an existing product for sale
26	Self manufacture of product for improvement of an existing process
14	Purchase of product for improvement of an existing process
9	Self manufacture of new product for sale
2	Incorporate a purchased product into existing product for sale
1	Use of new process to improve existing product for sale
1	Supply a raw material or equipment to other proposed uses

(From: P. Wright, RESEARCH/DEVELOPMENT 9/1966)

One of the more interesting aspects of these particular results is that incremental improvements of product or production systems appear to far outweigh the start-up of new products or processes.

WHERE INNOVATIONS ARE USED

USE A NEW PROCESS

SUPPLY SOMETHING
NEW TO OTHER
PROCESSORS

INCORPORATE PURCHASED
DEVICE INTO EXISTING
PRODUCT FOR SALE

5.5 What are some "secondary" uses of information gained through a technology transfer process?

A. Technical information is used in a broad variety of important ways other than physical incorporation into a process or product:

-
- * Using testing methods to improve measurement of product characteristics, product reliability, or process reliability
 - * Extending a market for present or proposed products
 - * Speeding up product development
 - * Confirming a feasible area of research investigation
 - * Extending knowledge of alternative input supplies and suppliers
 - * Using "baseline data" for:
 - Feasibility studies of product cost, product diversification, process improvement
 - Improving the firm's design capabilities
 - Preparing proposals
 - Evaluation of firms R&D proposals
 - Evaluating the effectiveness of quality control programs
-

"SECONDARY" USES OF TRANSFERRED INFO

5.6 How does one identify technology that might be ready for transfer?

- A. Every technology being developed by an R&D program is a potential candidate for immediate technology transfer. Any technology is really ready for transfer when industry says it wants the technology.**

The technology transfer manager must maintain a high level of awareness of each individual technology that the R&D program is trying to develop, and confer frequently with R&D managers to ascertain what is ready now and what might be ready in the near future.

Regularly circulate brief statements of progress and results in R&D to potential adopters, to keep them aware of what might become available. Then intensify the technology transfer effort when adopters request it.

"Technology readiness" depends to a great extent on the target audience for the transfer. For example, if the desired transfer is to a firm that will manufacture the technology as a product, then the transfer should begin in earnest when the first bench-scale prototype (or other early product) appears to perform in desirable ways.

On the other had, if the transfer effort is to assist a new manufacturer or service firm transfer the technology to a large consumer audience, the effort should not seek high level of publicity until consumer-oriented testing has worked out all of the "bugs" that might retard consumer acceptance.

Another important aspect of the "technology readiness" factor is that one should keep up with technology that is being developed privately or by "competing" agencies or in the private sector. This is important from the point of view of:

- * Maintaining credibility with audiences that the technology transfer agent knows what is going on in general, and**
 - * Meeting the usual Federal requirement that Federal technology transfer programs help with the transfer of technology beyond just that developed by a specific R&D program (e.g., industry-to-industry transfers).**
-

IDENTIFYING "READY" TECHNOLOGIES

A. AVENUES FOR IDENTIFICATION:

- * Promises in R&D proposals**
 - * Interviews of R&D program managers**
 - * R&D project quarterly and annual reports**
 - * R&D test results**
 - * Formal R&D program progress report systems**
 - * Inquiries from industry**
 - * Patent searches**
 - * Technical database searches**
 - * Technical journals**
 - * Trade association journals**
 - * Conferences and meetings**
-

B. VERIFICATION OF INDUSTRY INTEREST:

- * Circulate brief statements of results of R&D to potential adopters .**
 - * Intensify effort to transfer specific technologies when potential adopters request it.**
-

5.7 What must a technology transfer manager do to assess the readiness of technologies for transfer?

- A. Focus your attention on the readiness of the R&D side to transfer information, and the readiness of the adopter side to accept, assimilate, and use the information.**

-
- 1. Work closely with R&D managers and their R&D performers. Help them to ascertain and ensure that all major technical uncertainties about the technology are either resolved or understood.**
 - 2. In the initial phases of R&D, once a new product seems technically feasible, work to elicit interest in potential producers of the technology. "Push" - lightly, until producer interest appears. Interesting reports on overall program R&D progress are one good way to stimulate this initial interest.**
 - 3. Encourage the R&D component to contract out engineering fabrication work whenever possible. This will both test the adequacy of and clarify the technical information about the technology, and can help to resolve whether state-of-the-art approaches can be used to produce the technology.**
 - 4. Attempt to enroll technology producers in cost-shared R&D for further development of the technology. Assist the R&D program managers in ascertaining the capability of the interested firm to help develop the technology, or the firm's ability to learn how to produce the technology.**
 - 5. In later stages of development, rely on industry wisdom to ascertain if the technology, in its present state of evolution, is both producible and marketable.**
-

TECHNOLOGY READINESS CHECKLIST

- ☐ USER'S NEED IDENTIFIED
- ☐ USER'S NEED ANALYZED
- ☐ TECHNICAL CONCEPT IDENTIFIED
- ☐ CONCEPT SEEMS FEASIBLE
- ☐ R&D APPROACH IDENTIFIED AND PLANNED
- ☐ R&D IN PROGRESS
- ☐ POTENTIAL MANUFACTURERS IDENTIFIED
- ☐ WORKING PROTOTYPE READY
- ☐ FIELD-SCALE DEVICE READY
- ☐ SPECIFIC ADOPTERS IDENTIFIED
- ☐ FIELD-TESTS COMPLETED
- ☐ ECONOMICS EVALUATED
- ☐ ALL AUDIENCES IDENTIFIED, CONSULTED
- ☐ FINAL MODES AND MECHANISMS SELECTED
- ☐ FINAL PHASES OF INFORMATION DISSEMINATION
- ☐ CONTINUED TECHNOLOGY ADAPTATION WORK
- ☐ CONTINUAL TECH. TRANS. EVALUATION AND FEEDBACK

(R&D Cycles)

5.8 What should be transferred at each stage of development?

A. See the facing page for some of what is important.

All interested parties have a need to know:

- * Which needs are being addressed and which are not**
 - * Successes and failures of R&D projects**
 - * Performance of technology**
 - * Estimates of initial and life-cycle costs**
 - * Side effects of the technology**
 - * Reasons for emergence of opposition to the technology.**
-

In the process of information and device dissemination the manager must continuously remember that:

- 1. She or he is working to persuade as well as to inform.**
 - 2. All technology transfer interventions must be tailored to reduce specific adopter uncertainties.**
-

TRANSFERRABLE INFORMATION / DEVICES

USER'S NEED

- Description of needs
- Analyses of needs

TECHNICAL CONCEPT IDENTIFIED AND FEASIBLE

- Descriptions of concepts
- Relationships of concepts to needs
- Lists of orphan technical concepts

R&D PLANS AND PROGRESS

- Relationships between projects and needs
- R&D project plans, status, progress
- Consultations with potential manufacturers
- Status of cooperative projects
- Technology status bulletins
- Technical results
- Description of R&D methodologies
- Computerized technical models, submodels

WORKING DEVICES (PROTOTYPES or FIELD-SCALE)

- Hardware, software
- Tests to industry specifications
- Testing methodologies
- Cooperative lab or field tests
- Participation in further adaptation
- Anything that might engender manufacturer's interest
- Market studies
- Information for emerging opposers

SPECIFIC ADOPTERS IDENTIFIED

- Results of performance tests
- Results of economics feasibility studies
- Interview of potential adopters
- Test marketing results

FEEDBACK

- Identities and characteristics of first adopters
 - Pace of adoption
 - Continuing barriers to adoption
 - Needs for additional adaptation of technology
-

6.0 SELECTING APPROPRIATE MECHANISMS

1. What should be considered when selecting technology transfer mechanisms in a Technology Utilization program?
 2. Nature and Status of the Technology
 3. Nature and Status of the Industry
 4. External Economic Factors
 5. Political Philosophy of Decision-Making and Perceived National Priorities
 6. Budgetary Constraints and Options
 7. Nature of the Audience
 8. Summary: A Matrix of Mechanisms' Appropriateness
-

GUIDE to Section 6.0

Section 6.1 describes the origin and intent of Section 6.0.

Sections 6.2 through 6.7 describe situational aspects of technologies, audiences, and the Federal R&D Program milieu, and how to manage some of those situations.

Section 6.8 gives a tabular summary of the appropriateness of generic technology transfer methods in meeting selected Technology Utilization Program objectives.

6.1 What should be considered when selecting technology transfer mechanisms in a Technology Utilization program?

- A. This Section describes many of the important issues that specific technology transfer mechanisms must address.**

We feel that it is impossible to present a cookbook that dictates when specific technology transfer methods should be applied. The technology transfer process, at its best, is much too people-oriented to allow that. Moreover, most of the quantitative analyses of methods have been performed for Spin-Off programs, rather than for Technology Utilization programs.

What we present here is a compendium of direct experience, consultations with others, and insights from the literature. The considerations listed on the facing page are discussed in turn in this Section.

One of our interests here regarding "mechanisms" is to differentiate the utility of applying information, training, and personnel shifts to knowledge gaps. We have a similar interest in the much thornier question of the relative values of applying financial incentives and regulations in the economic and political arenas.

Some of the specific considerations discussed here could fit under a number of topics. For example, "Constituency Building" could easily fit under both "Political Philosophy" and "Nature of the Audience".

Moreover, it should be apparent that some of these considerations interact strongly with each other. For example, the novelty and complexity of technology interact both with each other and with the technical sophistication of industry. And cyclical economic factors interact strongly with political philosophy.

CONSIDERATIONS IN SELECTING MECHANISMS

- **Nature and Status of the Technology**

- **Nature and Status of the Industry**

- **External Economic Factors**

- **Political Philosophy of Decision-Making
and Perceived National Priorities**

- **Budgetary Constraints and Options**

- **Nature of the Audience**

6.2 NATURE AND STATUS OF THE TECHNOLOGY

A. COMPLEXITY OF THE TECHNOLOGY

Simple (effective, cheap, and reliable) technologies transfer rapidly. The visibility of the early adoptions is a critical factor (Everyone saw some else with an electronic calculator, and as the price decreased, almost no advertising was needed). Initial demonstration leads to rapid adoption via word of mouth, eyes-on or hands-on experience, and the operation of status forces. Larger fixed installations (e.g., an active solar heating system) are not as visible to as many people, and their components are more mysterious.

Complex technologies often require the intermediation of a firm that is accustomed to producing and using complex technology. But even in this case, a firm familiar with complex technology (e.g., aerospace manufacture) may have difficulty interacting with markets accustomed to simpler technology (e.g., city traffic light engineers).

B. IS THE TECHNOLOGY CONSUMER- OR INDUSTRY-ORIENTED?

If the technology is highly-consumer oriented, the transfer must be to firms that are skilled in the manufacture, marketing, and servicing of consumer products. The initial transfers are often accomplished in the high cost and status portion of the segregated market. Then the technology percolates downward into lower-cost markets. This is true of much automobile technology and of many innovations in the housing industry.

C. IS THE TECHNOLOGY OLD OR NEW?

If the technology is relatively "old" it will be adopted incrementally. If the technology is industrial, the innovations can often be applied to the existing capital stock. The sequential addition of new heat recycling devices to coal electric plants is a good example. However, if the technology is both "old" and consumer-oriented, market penetration opportunities will be strongly related to the residual lifetime of the current stock (e.g., hot water heaters, color TVs).

When the technology is "old," the existence of many competitive suppliers means that the innovations must be very cost competitive in order to diffuse; most of the suppliers will be working close to cost margins. By contrast, a very new technology will often allow the innovator and first adopter to capture financially a relatively large fraction of the social benefit -- and thus technology cost might be a minor consideration. This situation pertains to mainframe computers, proprietary drugs, and even disposable diapers.

A new technology may require the intentional creation of entirely new firms or industrial sectors.

If the technology is new, you should expect to detect the primary bottlenecks to wide-spread adoption only after the diffusion process has started. For example, as of 1984 the most severely limiting aspect of geothermal technology appears to lie not in mechanical performance or cost, but

C. IS THE TECHNOLOGY OLD OR NEW? (Continued)

rather in the inability to predict long-term reservoir performance with the accuracy and confidence sufficient to convince investors and lenders to fund large projects.

D. SIZE OF THE POTENTIAL MARKET

In large markets, large firms (e.g., General Electric, Sears) will take over the reliability assurance, marketing, and provision of consumer-oriented servicing. In relatively small markets, the Technology Utilization program may have to establish and support technical assistance centers to market, advise adopters, and advise inexperienced servicing personnel. Such centers can be established at and through National Laboratories, universities, A&E firms, or general consultants.

E. TECHNOLOGY BOTH NEW AND COMPLEX

Here, the Technology Utilization program must maintain a technical assistance capability. The capability must be responsive to industry, which is sometimes a difficult task if the capability is part of a traditional university department. Research institutes or National Laboratories are often better equipped to perform this function.

The Technology Utilization program might have to support the start of new firms. The critical element is the assembling of enough expertise to ensure that the technology can be produced commercially. A traditional, successful approach has been to support the development of the technical expertise in a university setting. Once the technology seems ready for commercial adaptation, the expertise is transferred to or mated to an appropriate commercial vehicle, e.g., a new venture or a university-industry cooperative arrangement. The Technology Transfer agent can facilitate the final step by keeping potential industrial partners aware of R&D progress, and by helping the university actors to maintain the patentability of the invention.

The Technology Utilization program must try to protect centers of such expertise from vagaries of funding. National Laboratories are often less susceptible to variations in funding than are universities.

6.3 NATURE AND STATUS OF THE INDUSTRY

A. HIGH-TECH OR LOW-TECH INDUSTRY?

A relatively difficult situation occurs when "complex" and "modern" technology (e.g., something based on computers) is being introduced into a traditional industry (e.g., steel making). While the benefits of the technology might be highly apparent, the firm's self-perceived capacity to understand, operate, and service the technology is often very low. Turnkey approaches can solve the initial technology adaptation and site-specific installation problems, but leave the adopter open to fears about long-term maintenance and servicing.

Full-service contracting is often necessary in such situations. It will be most valuable and acceptable if it includes a strong end-user training component. This is often demanded by foreign governments in international transfers of technology, and is just as applicable to domestic technology-transfer situations.

B. ORIENTED TO CONSUMERS OR TO OTHER INDUSTRIES?

Technology spin-off programs have found that the best high-technology firms, from which they procure their mission-oriented technology, have relatively low capability or even interest in marketing technology to new sectors. Good market organizations is essential when trying to promote consumer-oriented technology.

C. NEW OR MATURE INDUSTRY?

Price competitiveness is higher in mature industries than in new ones. (This may not be the case for "dying" sectors.) This means that attempts to transfer technology through mature industrial paths may require financial subsidies. There may be local and national political pressure to use this route.

However, mature industries that perceive a strong need to shift their business focus can offer a pool of management talent that, when supplemented with appropriate technical expertise, can be a powerful asset in technology transfer. Personnel shifts then are a most important mechanism.

D. SMALL OR LARGE BUSINESS FIRM?

Small firms often appear to be afraid of interacting with the Government. Red tape and fear of potential loss of patent rights are often cited as major barriers. Another barrier is the fact that small firms are not as able as large firms to bear the financial risk of research and product development. Substantial cost sharing of R&D may be necessary to enroll such firms.

Many large firms find it difficult to approve development projects for highly innovative technology. They are often reluctant to accept personnel transfers, because they fear the loss of proprietary secrets. For many reasons, large firms now often end up purchasing technology after it has first been brought to market by smaller firms.

The technology transfer manager should also note the current relaxation of anti-trust policies to allow consortia of U.S. firms to collaborate on R&D. This trend will have large and somewhat unpredictable effects on the relationships between large and small firms in the development process.

6.4 EXTERNAL ECONOMIC FACTORS

A. BOOM OR BUST?

It is generally easiest to transfer technology during a boom period. This is especially true of technologies that require the development or rapid expansion of new consumer markets.

On the other hand, some rapid-payback cost-sharing technology (e.g., energy conservation devices) can be transferred relatively easily during downturns in the economy.

B. THE COST OF CAPITAL

Very high interest rates will impede the transfer of technologies with very high capital-to-O&M cost ratios or with very long construction times. This factor is relevant to many types of electricity generating technology.

When the long-term cost of capital is perceived to be very uncertain, potential adopters will eagerly forego apparent economies of scale for the risk reductions associated from smaller modular systems.

C. TEMPORAL WAVES IN TECHNOLOGY UTILIZATION

It is probable that there are medium-term and long-term changes and cycles in the nature and relative economics of the use of technology. One factor in this is related to the classical economic insight that the relative costs of capital, labor, and specific raw materials tend to change over time, as the cost of energy did during the 1970's.

The life expectancies of major capital items and skills needed to support such investments can also provide opportunities for technology adoption. For example, the need to renovate the heating systems in the U.S. pre-World War II building stock has provided the opportunity to install on a large scale, modular, electronically controlled heat pump technology that provides both heating and air conditioning.

D. MANAGING SUB-ECONOMIC TECHNOLOGIES

Technology Utilization programs are often called upon to manage the development of sub-economic technologies. All of the components and subassemblies might be technically feasible for large markets. This situation applies, for example to photovoltaics, fuel cells, some geothermal energy, and most synfuels processes. In fact, the most typical "mission" for a Technology Utilization program may be to bring a working but sub-economic technology into the economic range.

This is not easy, for the program has to accomplish this within the context of varying budgets, start and stop reactions in the marketplace, a certain amount of non-concealable technical and market failure, and a period of time that often exceeds the tenure of any single manager.

Some of the strategies that need to be considered here are:

- * Concentration by the R&D program on improving first those parts of the technology that could achieve some consistent visible successes in cost reduction
- * Enlisting the cooperation of industries that can make enduring profit by applying selected subsystems to other markets, and thereby eventually bringing down the costs of the subsystems
- * Use of market subsidies or directed Federal purchases to bring the technology down the cost-learning curve.

The most important point here, however, is that the Technology Utilization manager can not succeed in this effort unless he has consistent long-term government and public support. In this situation the Technology Utilization manager must direct a considerable part of his effort to ensuring that the technology has adequate constituencies both inside and outside the government.

6.5 POLITICAL PHILOSOPHY OF DECISION-MAKING AND PERCEIVED NATIONAL PRIORITIES

A. TECHNICAL RESEARCH "VERSUS" MARKET INTERVENTIONS

The administration's funding emphasis since 1981 has been on technical research (into which a technology transfer component may be designed) rather than market interventions which by definition incorporate technology transfer. A problematic effect of this policy is that it has tended to cut into the technical assistance function that is so often needed to spread a new technology among many small users. One legitimate way to encourage the continued health of centers that provide technical assistance is to locate some of the final stages of "adaptation" R&D there, perhaps with cost-sharing from potential manufacturers of specific technologies.

B. ISSUES OF SUBSTITUTION AND DISPLACEMENT

A number of energy technologies, for example, that are being developed with assistance from the government compete directly for private sector market shares. Moreover, the relative successes of one or the other of the technologies will cause economic harm to one or another owner of resources or equipment. Which should win out, or receive relatively more Federal support in development?

These are questions of national goals and perception, and of the national will to devote current resources to develop a range of options. Questions of the long-term value of natural resources and sunk investments often become very important political issues.

As such these political issues need to be resolved, at an Agency, Secretary, or National level. The Technology Utilization manager must often play both a responsive and a partisan role in this process.

C. CYCLICAL NATURE OF PROGRAM FUNDING

This concern is a result of the above two factors. Its effects are to place centers of technical expertise at risk, and to reduce the effectiveness and pace of specific projects at certain times.

Direct Presidential or Congressional support for "start" projects, while extant, protects program funding-deleterious variations. Large-ticket items in the budget might help you get larger budgets for the other smaller ticket items, or they might cut into the latter.

If support for a program wanes temporarily, the most important things to protect are the continuity of technical expertise and the continuity of your working relationships with non-Federal product champions. If things get really tight, archive the program results for revivification later. Keep accepting and reading unsolicited proposals. Continue to develop contingency plans and justifications for funding them if the spigot is turned on again. Keep track of the locations of (often mobile) promising engineers and scientists.

A reduction in your budget may also indicate that you are losing your original private-sector constituency. Unless your constituency can be re-activated, you can expect eventual termination of your program.

6.6 BUDGETARY CONSTRAINTS AND OPTIONS

A. THE CORE SOLUTION - KEEP YOUR EXPERTISE ALIVE

Regardless of what happens to your budget, keep the last few dollars in place to maintain communication among your best few technology-oriented and market-oriented experts.

B. WIDE FLUCTUATIONS IN BUDGETS

Active T.T. modes (see Section 3.1) are both more effective and expensive than passive modes. When your funding goes up, get active mechanisms in place as rapidly as possible. If higher funding is expected to be temporary, to last for only a year or two, invest in hardware and important field tests. Do not invest it in new people who will require three to five years of support prior to providing the next big breakthrough.

When your funding goes down, alert those in industry who have come to rely on your more active modes that you have to become more passive. So they will have to switch to somewhat more active stances to keep up with what is coming out of your program.

C. VERY TIGHT BUDGETS

When R&D program budgets are tight, you will have to rely on the more passive modes and mechanisms. When budgets are extremely tight, two important mechanisms are to:

- * Archive some of the simplest information about the technology in forms that will allow its later reactivation.
- * Maintain directories of who in industry, universities, and government has been involved in technology development.

D. FUND T.T. EFFORTS FROM R&D PROJECT BUDGETS

Once a working prototype exists, most engineering work to improve its performance, and most critical field tests can be labelled as either "R&D" or "technology transfer". Be judicious, but fund necessary work from either pot, as needed.

E. SHARE T.T. WORK WITH OTHER AGENCIES

In many instances the technology you are working to develop is one answer to a goal or problem that a different Federal or State agency is trying to solve. Do the (relatively) hard work of getting a legitimate interagency joint program going. It may be somewhat harder for your Department to reduce the scope of such agreements than to reduce the size of your primary budgets. The down side, however, can be that you later are stuck with the interagency project and have to fund it from budgets you'd rather use elsewhere.

F. RESTRICTIONS ON HEADQUARTERS MANPOWER LEVEL

If you are highly constrained on how many staff you may have in your Headquarters organization, consider establishing a "System Integrator"(SI). The SI is a non-Federal organization whom you fund to analyze, plan, and sometimes execute part of the critical work for which your shop lacks sufficient manpower. The DOE Federal Contract Research Centers were established in part as agents of this sort. You will lose some control, but can gain much technical effectiveness.

G. TRAVEL RESTRICTIONS

Federal restrictions on travel budgets are a perennial limit on the effectiveness of Washington Headquarters staff interaction with industry. If you have sufficient funds otherwise, make sure that you field technology transfer agents have sufficient funds to travel, and make sure that they actually use them for face-to-face work.

6.7 NATURE OF THE AUDIENCE

A. PRODUCER OR CONSUMER?

The market-place consumer (in the John Q. Public sense) needs greater assurances of product reliability and service availability than does the technology producer (e.g., a manufacturer).

It is also widely believed, although this may be changing in the 1980s, that the model American consumer is much more responsive to low front-end costs than to low life-cycle costs. The technology producer and industrial user of technology are more likely to take life-cycle costs into account.

B. NOVICE OR SOPHISTICATE?

Some sophisticated audiences will come knocking on your door to initiate cost-shared R&D projects. Others, the novice adapters, will be induced to participate only if a government program assumes the most significant perceived risks.

This difference is one reason why it is not easy to set Federal cost-sharing for product development and adoption at fixed levels across all projects.

C. SMALL OR LARGE AUDIENCE?

If your audience is small, you can rely on face to face contact.

If your potential adopter end market is very large, you may have to do other things, such as:

- * Prove the apparent need through test marketing
- * Do broadcast advertising
- * Identify and work with those who might be first adopters: they tend to have spare cash, and a reputation for being sensible early adopters of other technologies
- * Work directly with marketing intermediaries to convince them that they will profit by promoting the technology.

D. WHO IS THE PRIMARY AUDIENCE?

Two primary audiences always leap to mind: Consumers and producers. Should you target the consumer, to induce demand pull? Or the producer, to facilitate technology push?

A substantial series of case studies suggests that it usually more important and effective to target the technology producer, especially if that producer can be a manufacturer and marketer of the technology. The reason is that it takes substantial time and money for a manufacturer to analyze a new technology with respect to

both its producibility and its marketability. Cost-sharing the initial investment in a new technology is likely to entrain him into continuing to produce it and to become an effective marketer for it.

If the Federal government has staged a demonstration for users without enrolling a non-Federal producer/servicer to be in the thick of the demonstration, then - no matter how successful the demonstration was in resolving the uncertainties of potential users -- some technology producer is likely to have to solely-fund the resolution of any uncertainties with respect to the producibility, marketability, and profitability of the technology. Or the Federal program might have to come in behind the demonstration with additional funding to enroll a manufacturer.

There are times when Federally-funded engineers want to "demonstrate" a technology before it is ready for commercial use, mainly in order to attain a more realistic test-bed for technology development. If no non-Federal manufacturer can be enrolled to play a leading managerial role in such an effort, it should not be given the publicity or expectation-raising status of a "demonstration". "Field test" or field-adaptation project" might be a better appellation.

E. SECONDARY AUDIENCES

These are financiers, insurers, distributors, local servicers, etc. Their uncertainties about the wisdom of investing in a new technology are as great as those of manufacturers and consumers. And the information and understanding they need is often as technically-oriented and detailed as that needed by a manufacturer. They are integral parts of many Technology Delivery Systems, and need to be brought into technology transfer programs right along with the other, superficially "primary", audiences. Examples are: local architects -- with respect to the acceptance of passive solar houses, and electric and gas utilities -- as potentially effective marketers and services of energy conservation technologies.

6.8 Will you summarize some of these relationships between Technology Delivery System conditions and appropriate mechanisms for technology transfer?

- A. A.G. Linhares developed the summary shown on the facing page. It was presented at a 1977 conference on the Management of Federal Research and Development.**
-

One of the most striking aspects of this matrix is the amount of attention it devotes to "market development" objectives: Development of awareness of needs, Alleviate risk and Aggregate market.

A narrow construction of "technology transfer" often focuses the bulk of Federal T.T. activities on developing non-Federal technical expertise, and especially the expertise of potential suppliers. The prominence of "market" objectives here should remind you that conducting market intelligence and analysis is an essential part of "technology" development, and is a function that can be markedly accelerated by the information gathering and statistical analysis capabilities of the Federal government.

SUMMARY: APPROPRIATE MECHANISMS

OBJECTIVES	PROGRAM AREAS										
	R&D PROJECTS	FIELD ORIGINS & DIRECT ASSIST	TAILORED DOCUMENTS SEMINARS WORKSHOPS	TRAINING & PERSONEL EXCHANGE	SPECIAL SURVEYS	SPECIAL FEDERAL USER MECHANISMS	DEMONSTRATION PROGRAMS	INFORMATION SERVICES	PERFORMANCE SPECIFICATIONS & STANDARDS	INTERAGENCY PROGRAMS ACTIVITIES	
● DEVELOP AWARENESS OF NEEDS											
● DEVELOP TECHNICAL EXPERTISE USER											
● DEVELOP TECHNICAL EXPERTISE SUPPLIER											
● ALLEVIATE RISK											
● AGGREGATE MARKET											
● COORDINATE FEDERAL PROGRAMS

MAJOR IMPACT

SOME IMPACT

MINOR OR NO IMPACT

THE UNITED STATES OF AMERICA
DEPARTMENT OF THE ARMY
OFFICE OF THE CHIEF OF STAFF
WASHINGTON, D. C. 20315

7.0 PLANNING AND MANAGEMENT

- 1. The Management Role of Technology Transfer Planning**
 - 2. Three Levels of Planning and Management**
 - 3. Four Alternative Focuses for Planning**
 - 4. The Role of Audience Participation in Planning**
 - 5. Monitoring and Reporting**
 - 6. Four Steps in Tactical Planning**
 - 7. Additional Steps in Strategic Planning**
 - 8. Strategic Planning: The R&D Director's Checklist**
 - 9. Tactical Planning: The T.T. Manager's Checklist**
 - 10. Operational Planning: The T.T. Agent's Checklist**
 - 11. T.T. Program Integration Checklist and Matrix**
 - 12. T.T. Evaluation Checklist**
 - 13. T.T. Methods Checklist**
-

GUIDE to Section 7.0

Section 7.1 describes and tabulates ways in which planning activities can help solve management problems.

Sections 7.2 through 7.5 clarify some fundamental considerations in planning and management.

Sections 7.6 and 7.7 describe the fundamental concepts and activities of strategic and tactical planning.

Sections 7.8 through 7.11 provide detailed checklists for T.T. program and project planning, and T.T. program integration.

Sections 7.12 and 7.13 present "reminder" checklists of T.T. evaluation questions and T.T. mechanisms.

7.1 Why is the planning process one of the most important tools of technology transfer management?

A. For three reasons:

1. Planning helps you find ways to cope with the usual temporal variability in Federal R&D and Technology Transfer policy and budgets.
2. Planning allows you to keep technology transfer functionally integrated with the R&D components of your program.
3. Planning processes are one of your primary legitimate tools for getting information from industry and consumers concerning their functional needs and their awareness and commitment to your program's technology and R&D work.

Although this Section is about technology transfer program management in general, we believe that a "planning" orientation is a very useful way to optimize the management of the diverse needs, issues, and activities of technology transfer.

The functions of management are to define, direct, allocate resources among, monitor, modify or control, and report a program's activities. Once a technology transfer program's purpose, scope, total resources, and constraints have been defined, planning processes play a central role in the "defining", "directing", "allocating", and "reporting" functions.

The functions of planning are at least to:

1. Involve most major actors in value decisions
 2. Provide coordination or direction of others activities
 3. Optimize the immediate effectiveness of technology transfer activities with respect to R&D program goals
 4. Optimize and minimize consumption of program resources
 5. Specify feedback and reporting requirements both up and down the management chain
 6. Optimize the long term strategy and management of both the technology transfer and R&D program it serves.
-

PLANNING ACTIVITIES THAT FOSTER MANAGEMENT EFFECTIVENESS

MANAGEMENT FUNCTION	TYPICAL CONDITIONS	PLANNING ACTIVITIES THAT FOSTER THE FUNCTION
1. Involve Major Actors in Value Decisions	<ul style="list-style-type: none"> * Important goals and factors are overlooked * Important actors are not included 	<ul style="list-style-type: none"> * Institutionalize participative planning * Include: R&D managers, technology consumers, manufacturers, opposers, your bosses and staff
2. Direct and Coordinate Actions	<ul style="list-style-type: none"> * No action * Misdirected actions * Incoherent interaction with industry 	<ul style="list-style-type: none"> * Frequent meetings of T.T. team(s) to review progress * Formal written plans, M.O.U.s * Sign-off on agreements * Designated T.T. program contacts for each main industry actor
3. Optimize Immediate Technology Transfer Effectiveness	<ul style="list-style-type: none"> * "Squeaky Wheel" approach to allocation * Too much business as usual 	<ul style="list-style-type: none"> * Formalize technology readiness assessments * Analyze and update map of Technology Delivery System * Be the expert on the utility of modes and mechanisms * Provide rewards for T.T. agents
4. Optimize / Minimize Use of Program Resources for Technology Transfer	<ul style="list-style-type: none"> * All allocations are made on an ad hoc basis * Weak justifications for T.T. allocations 	<ul style="list-style-type: none"> * Specify measurable objectives for R&D program and T.T. operations * Estimate impacts of proposed actions upon objectives * Fund high impact / high priority actions
5. Meet Reporting Requirements	<ul style="list-style-type: none"> * No feedback * Slow feedback * Pressure from above * Incomplete feedback and reports 	<ul style="list-style-type: none"> * Identify recurring and sporadic reporting needs * Include measurable outcomes in reporting specifications in contracts * Keep reports timely but use complete data
6. Optimize Long-Term Strategy	<ul style="list-style-type: none"> * Variability in funding levels * Policy changes * Changes in markets and industry infrastructure 	<ul style="list-style-type: none"> * Keep line between use of R&D budgets and T.T. budgets somewhat blurred * Modulate T.T. mechanisms, not goals, as policies change. * Keep data on markets and feasibility of technology up to date

7.2 What are the organizational levels of management and planning typically required for effective technology transfer?

A. There appear to be three important levels of organization:

1. **OPERATIONAL:** This is the field level, or single technology transfer agent level. The activity emphasis is on person- to-person interaction with potential technology adopters. This level is sometimes organized along technology-differentiated lines, with each agent being responsible for "pushing" a specific group of technologies. Or it may be organized along industry-differentiated lines, with each agent acting to help specific industrial counterparts find technologies that meet specific needs. The former organizational style seems more typical among Federal programs and the latter among State and local programs.
2. **TACTICAL:** This level is represented by the Technology Transfer activities manager in a Federal R&D Program. He usually is not directly involved in managing specific R&D projects, but rather, is often part of the "Integration" branch of the Program. The overall responsibility is the Program's overall T.T. activity effectiveness in an annual time-frame. The activity emphasis is on: (1) designing, monitoring, and controlling the overall T.T. activities of the Program, (2) ensuring that information on user needs for technology adaptation, gathered by T.T. operations staff, is communicated to the Program's R&D managers, and (3) preparing the management reports on the T.T. aspects of the Program.
3. **STRATEGIC:** This level of organization is responsible for the overall effectiveness of the R&D Program, in mid-term and long-term contexts. From this level, T.T. is viewed as an essential tool for Program effectiveness, with respect both to transfer of actual technologies and to public awareness and constituency building. The activity emphasis is on: (1) ensuring the Program receives the appropriate level of funding and manpower to achieve its policy goals, (2) sustaining the awareness, attention, and support of the industry actors who will produce or use the technologies in the marketplace, and (3) setting the level of T.T. activities and budgets relative to other activities of the total R&D program.

A check list of typical responsibilities at each of these levels is shown on the next page.

T.T. MANAGEMENT/PLANNING LEVELS/RESPONSIBILITIES

1. T.T. FIELD AGENTS - OPERATIONAL PLANNING

- * Selection of specific audiences (technology producers and users) to attempt to influence
- * Detection and reporting of industry needs for technology, and technology adaptations
- * Execution and reporting of field-level actions

2. T.T. PROGRAM MANAGER - TACTICAL PLANNING

- * General coordination and monitoring of T.T. agents' operations
- * Integration of market intelligence
- * Allocation of T.T. effort among specific modes and mechanisms
- * Allocation of T.T. effort among technologies, in cooperation with Program R&D managers, e.g., based on consideration of technology readiness and markets
- * Feedback to R&D Project/Program Managers re R&D program changes that could accelerate T.T.
- * Monitoring of Program's general T.T. effectiveness
- * Timely preparation of technical and management reports regarding Program's T.T. initiatives, budgets, results, costs

3. R&D PROGRAM DIRECTOR - STRATEGIC PLANNING

- * Maintenance of Program constituency relationships
 - * Relative funding emphasis to place on short-term and long-term R&D goals and objectives, and relative emphasis to be placed on T.T. efforts, in context of overall R&D program goals and budgets
 - * Responses to higher-level policies, requests, and directives
 - * Actions to influence higher-level policies
-

7.3 How do planning and management focus and tactics vary with Technology Delivery System characteristics?

A. We can identify four main "styles" of tactical Technology Utilization program technology transfer focuses:

- 1. Broadcast:** Many "small" players need information.
- 2. Coordinated:** Program assists additional firms in entering a particular technology arena.
- 3. Networked:** The many firms already in the target business need alerting regarding technology improvements and breakthroughs.
- 4. Mission-Managed:** Long-term interactions with a few prime contractors are sufficient for mission-related technology transfer.

More detailed descriptions of these focuses are given below.

- 1. BROADCAST:** Required when a great many new adopters are needed. That is, the economic or social value added per marginal adopter is high, e.g., for architects' learning passive solar principles.

Examples: (1) DOE Energy Conservation and Renewables outreach efforts re: small distributed systems. (2) Agricultural extension programs. (3) HUD programs on energy conservation. (4) DHHS cancer therapies Hot--Line for physicians.

Transfer Modes: Centrally organized. Federal program must fund most of the technology adaptation effort. Broadcasting of technical information, training.

Planning Emphasis: Much attention to small user needs and characteristics.

- 2. COORDINATED:** A few large technology producers/users are in place, and are effective acceptors/adaptors -- but energy system goals require the cloning of more players, or intense coordination of multiple existing players.

Examples: (1) DOE-Renewable Technologies, central systems (e.g., geothermal 50-100 MW electric plants, solar thermal electric plants). (2) DOD-DARPA Artificial Intelligence Systems Development Project. (3) Computer industry MCC project. (4) State-funded technology transfer programs to boost State economic productivity.

2. COORDINATED (Continued)

Modes: Close contact with industry advisors. Direct work by technology transfer agents with entry-level firms.

Planning Emphasis: Industry advisory inputs. Selecting and training potential technology adopters.

3. NETWORKED: Many effective technology production/use firms in place. Many desired changes are incremental. Firms are accustomed to adopting and adapting new technology into existing systems. Engineers are a prominent target.

Example: DOE-Fossil: communications via engineering associations.

T.T. Modes: Loosely managed. Surrogate managers (e.g., Electric Power Research Institute) manage technology adaptation work that is jointly funded by Federal and/or State governments and industry. Main Federal task is to disseminate information about technology via professional associations, journals, etc.

Planning Emphasis: Ensuring that technology breakthroughs are disseminated through cross-disciplinary channels. Responding to industry feedback re technology information needs.

4. MISSION-MANAGED: Long-term relationships with a few prime contractor technology producers and/or a few prime technology consumers are required and sufficient to complete agency's mission.

Examples: (1) NASA - space missions. (2) DOD - directed energy systems development.

Modes: Major contractors handle most of the education of subcontractors. The main Program requirement for technology transfer is spinoff of concepts, subsystems, components to organizations with different goals and missions. Technology reviews, published or on-line catalogs, licensing agreements are the main tools.

Planning Emphasis: Timeliness in achieving mission. "Reverse" technology transfer into the Program to serve the primary mission. Cost versus macro-economic and/or political value of an effective technology spin-off program.

7.4 Why is audience (client) participation important in planning technology transfer program activities?

A. Audience participation in planning serves a number of functions. It:

- * Calibrates program directions to fit clients' needs
- Improves program understanding of clients' readiness and barriers regarding adoption of technology, and
- * Provides audience individuals with incentives to support the program as constituents.

The overall goal of audience participation is to foster and sustain real cooperation and partnership between industry and government, with respect to the direction of R&D activities that ultimately depend on industry for full realization of their goals. Moreover, audience participation markedly accelerates the inevitable change and feedback that surrounds any effective innovation effort.

Federal R&D and Technology Utilization programs do not exist in a vacuum. The Department of Defense, NASA, Department of Agriculture, and the Food and Drug Administration all survive because they are needed, and because they are popular. The popularity stems in large part from keeping programs closely adapted to private sector interests, needs, and capabilities.

Here are some examples of useful audience inputs:

- * Need Calibration:
 - Usefulness of the technology, as it now is
 - Needs for adaptation of technology
 - "We've already solved that problem."
 - Potential producers' perceptions of markets
 - Potential users' perceptions of value
 - * Audience readiness and barriers:
 - "Here's another R&D approach you should try."
 - Needs for technical education
 - Technology opposers' issues and interests
 - * Audience incentives to support Program goals:
 - Advanced intelligence on emerging technologies
 - Personal or organizational public recognition
 - Sense of real participation, and contribution
-

USEFUL INPUTS FROM TECHNOLOGY TRANSFER AUDIENCES

AUDIENCE INPUTS

PROGRAM ORIENTATION

7.5 What are the most essential aspects of monitoring and reporting progress from T.T. program operations?

A. Service program evaluation researchers distinguish between "process" information and "effects" information reported from program operations. It is reports of effects that most impact a T.T. program's ability to get the financial and staff resources it needs.

- * **Process Feedback - Detection and reporting of number and types of service operations performed. Examples: "In 1984, the Program sponsored 8 workshops that were attended by 471 people." "Site visits were made to 89 industry executives and engineers." Process feedback is necessary. But it provides primarily indications of how the program's T.T. budget was spent, and how many people were contacted.**

- * **Effects Feedback - Detection and reporting of successes and failures in entraining the action by technology adopters. Examples: "Program-developed drilling fluids were used in 82 percent of the 35 hot water geothermal wells drilled in 1984." "430 new cogeneration units went on line in 1984."**

Effects feedback indicates which technologies are being adopted, and the rate of adoption. Reports of slow or no adoption may indicate areas where additional technical R&D might relieve an economic or institutional bottleneck.

The extra cost needed to monitor and measure such effects often prevents a program from making such measurements. But not monitoring is often "penny wise and pound foolish", for effects are the benefits that convince R&D program executives to pay for technology transfer.

There are many ways to collect effects feedback. Some of them may conflict to some degree with Federal restrictions on using questionnaires to elicit information from industry. Telephone surveys, which are more expensive but usually more effective on a unit basis than mailed questionnaires, are often used. Or an R&D or T.T. program can fund industry "technical analyses" of technology status and R&D needs.

- * **Reports from R&D managers and T.T. agents. Did X in fact adopt technology Y? Or, has technology Y ever been adopted? For example, ask R&D managers for T.T. audience contacts who have examined or installed a technology, and are willing to vouch for the technology's usefulness.**

- * **Reports from technology licensees, e.g., manufacturers. How many units of technology Y did you sell in 1985? You might try to include a requirement to report annual production or sales.**

PROCESSES REFLECT COSTS

EFFECTS INDICATE BENEFITS

information in Federal patent licensing agreements, or licensed on a per-unit-sold basis.

- Industry investment analysis reports. Some of these follow specific segments of industries at a level of detail sufficient to assess larger-scale impacts of R&D programs. Here, you pay the private sector investigator for intelligence about effects of your program.
- Review articles and advertisements in trade journals, for notices of technology availability.
- Distinguish between technology producers (i.e., manufacturers) and technology consumers (i.e., citizens, electric utilities). Producers and consumers often have quite different self-interests with respect to sales/purchase information. What you can not learn from one, you might learn from the other.
- Fund industry consultant analysts to review state-of-the-art technology usage. This may be the only way to get accurate pictures of how improvements in process-oriented technologies are affecting industrial practice.

7.6 What are the steps for planning a T.T. program?

- A.** There are two parts to planning a T.T. program -- strategic and tactical. Strategic plans drive the long range, say two to twenty-year, directions of a program. Tactics are, or should be, driven by strategy, and focus on shorter run goals. Both are important.

"Tactical" planning is what most people think of when they are "planning", so that is described first. Tactical planning methods are useful for both the tactical and operational levels of T.T. program management, as defined in Section 7.2.

The four standard steps for tactical planning are depicted at the top of the next page. You already do these things routinely. You might be able to improve the way you do them.

Planning methodology has advanced in the past twenty years, in two ways.

First, algorithmic and computer aids have been developed that make the administrative details of plan development and presentation less painful. Program Planning and Budgeting systems, Critical Path project planning tools, and Gantt and PERT charts are some of these aids. However, it is fair to say that the great bulk of Federal R&D programs still use these planning technologies in a horse and buggy fashion. Most tactical plans are created manually and then laboriously entered to the planning "aid" computer system. The advent of personal computers in Federal offices seems to be changing this.

Second, there are improved ways to get the "human" inputs into planning. These are reflected in the sequence of steps shown on the next page. We now understand that it is best to explore issues and problems in depth, before beginning the search for solutions -- this clarifies what has to be accomplished. And we know that "brainstorming" is an essential process, both for understanding issues and for developing useful problem-solution options -- that "off-the-wall" notions usually contain the seeds of creative insights.

An important thing to remember, in executing these steps, is that there are "problems" and there are "opportunities". Working from a "problem" outlook often becomes frustrating, since problems beget problems, etc. Using an "opportunities" framework can be much more useful, for it helps planners break loose from a status quo mentality, and is more satisfying in the long run.

STEPS IN TACTICAL PLANNING

There are four fundamental steps:

1. **Identify Needs and Issues** - This should be done before considering options for solutions. The essence is to get a true understanding of functional needs for generic and specific technologies. The details should be recorded for reference. In part this is the "market analysis" which the Technology Utilization Program must perform in detail, and update frequently.
2. **Identify and Detail Options** - The first stage is an uncritical nomination of options, "brain storming". This will uncover as many options as can be devised by the planning participants. The promising options should be fleshed out in moderate detail to help bound further analyses.
3. **Evaluate Options** - Some form of benefit/cost analysis must be done on the promising options. Technical performance, economic feasibility, and environmental/social acceptability must be considered. Ranges of certainty of estimates must be clarified. Probability of technical success is an important key-stone in these analyses.
4. **Select Best Options** - Some options are "musts", and have to be selected because of their critical urgency. Others must be ranked in a "value" framework. Values are usually multi-dimensional, and are commonly analyzed using a "Multi-Attribute Value Matrix", also known as a "Structured Value Matrix" or "Decision Matrix", with values as columns and options as rows. Options are then selected in order of highest integrated value, until all resources are committed. "Risks" can be accounted for by "Portfolio" analyses, which are often based on a "Risk-Adjusted Rate of Return". Programs with many synergistic options must be simulation--modelled in some detail.

7.7 What is strategic planning about, and how is it done?

- A.** When management problems arise, they can usually be handled on a tactical basis -- the application of current resources to restore progress to a planned path. But at times problems arise that are so large that only severe changes in resource deployment and managerial action are sufficient to restore even minimal equilibrium.

Strategic planning is a group of processes that can be used to anticipate severe problems, to prevent them, to mitigate their major effects, and -- more positively -- to be ready to capitalize on unexpected opportunities if such arise.

The goals and functions of strategic planning are to:

- * Position the Program favorably with respect to non-Federal realities of the technology marketplace, and with respect to other Federal programs.
- * Anticipate opportunities and major issues, in the context of the Program R&D Utilization Mission as a whole, and its relationship to other missions of the larger organization.
- * Maintain Program coherence, and buffer it from uncertainty, under conditions of growth, stability, and decline.

STRATEGIC PLANNING TOOLS:

1. **Broaden the Program Context.** Explore and analyze multiple dimensions, including geographical, temporal, organizational, political, technological boundaries.
 2. **Futures Casting.** Project world and Program conditions on a "What-if" basis. Search for major relationships and dependencies that might or are likely to vary over time.
 3. **Analyze the Competition.** What is it like now? How will it react to future trends?
 4. **Clarify Interests.** What deeper international, social, industrial, organizational, and individual interests lie beneath controversies that present themselves as issues? How do and will these interests interact?
 5. **Project a Successful Program.** Select technical and public relations niches that no other program could fill as easily. Focus on the major milestones, required breakthroughs, and the resources needed to reach those goals.
-

THE STRATEGIC ARENA

STRATEGIC PLANNING TOOLS (Continued):

6. **Translate Technology into Social Contexts.** So much of what happens to technology per se, R&D programs, and technology transfer efforts depends on the social contexts. The best strategies pay much attention to the interplay of societal functions that are served by various technologies.
7. **Prioritize Strategic Thrusts.** Identify and rate/rank strategic elements with respect to urgency, technical importance, and visibility. Especially, identify thrusts that have high ability to help the program access needed resources. Further, identify the variable external conditions that will alter the priority of each element. Anticipate when to enhance or to abandon specific strategic and tactical thrusts.
8. **Plan the Program Life Cycle.** Industrial products have life cycles. So do R&D programs and technology transfer initiatives. Design the life cycle of your program, rather than be a captive of it. Anticipate growth and shrinkage, and even when the Program as a whole should be terminated.

7.8 What are some practical "steps" for strategic planning?

- A.** A checklist of steps is sketched out here. You should be aware, however, that good strategizing requires frequent evaluation of many factors, in ways that make the "steps" seem to disappear.
-

[] 1. UNDERSTAND YOUR PROGRAM'S CONTEXT

- * The generic definition of your Program's goals
- * Industry market for your Program's technologies
- * Your Program's capabilities (budget, staff)
- * Industry market for Competing technologies
- * Bureaucratic/political climate of your Program
- * Typical variation in economic and political climates

[] 2. IDENTIFY FEASIBLE TECHNOLOGY DEVELOPMENT OPTIONS

- * Rely on science, technology, industry experts.
- * Technical, Economic, Social, Regulatory feasibility

[] 3. SELECT COMPETITIVE NICHES BY "FUTURE CASTING" SCENARIOS OF HOW POTENTIAL WINNERS WILL AFFECT THE WORLD

- * Benefits to specific marketplace actors
- * Impacts on business competitors
- * Political/Bureaucratic changes
- * Synergistic and Show-stopper effects

[] 4. SKETCH OUT DEVELOPMENT PATHS OF POTENTIAL WINNERS

- * Technical performance/cost of intermediate systems
- * Required technological breakthroughs
- * Characteristics of technology "champion"
- * Industrial stages to full market penetration
- * Possible opposition, and responses to same
- * Resource requirements for development

[] 5. FOCUS ON POTENTIAL BREAKTHROUGHS

"Breakthroughs" are very important to the success of a Technology Utilization Program. They must be sought in every strategic arena: technology, market development, publicity, incentives, bureaucratic turf development, etc. Breakthroughs both enhance the economic value of the Program, and keep it visible in ways that add to its support.

- * Create and identify technical and managerial breakthroughs.
- * Develop strong technical, economic, and public-relations connections between breakthroughs and the more conventional "linear" components of the program.
- * Promulgate available breakthroughs as the leading edges of the Program work and offerings.

MAP OF STRATEGIC PLANNING STEPS

[] 6. SELECT RESOURCE DEVELOPMENT INITIATIVES

- * What resources are needed beyond those in hand?
- * Who can provide those resources? What information or incentives are needed to convince them?
- * What disincentives are available to influence opposers?

[] 7. DEFINE PUBLICIZABLE BUSINESS/NATURE OF PROGRAM

- * What will sell? To whom? How quickly?
- * What is the "sales" leader target or goal?
- * What are the fall-back sales leader targets?

[] 8. IDENTIFY STRATEGIC CONTINGENCY SIGNALS

Identify warning signs that would induce you to shift your strategy at a later date, for example: programmatic successes or failures, economic or political upheavals.

[] 9. DEFINE PROGRAM IN TRADITIONAL GOAL & OBJECTIVES TERMS

These include: Goal(s) - generic, benefit/cost terminology, not quantified; Objectives - delegatable, measurable, quantified re performance and time; and Tactics - if strategic considerations dictate them. These definitions drive the management and publicizing of the Program using more traditional planning methods.

7.9 What must the T.T. Program manager consider in the tactical planning of a Technology Transfer effort?

- A. Here is a check list of major considerations, focused on a single technology transfer action.

Some guidance for the program integration of a number of such efforts is given in Section 7.11.

1. TECHNOLOGY VALUE AND READINESS FOR TRANSFER

- ☐ 1.1 What is the role of this technology in the overall scheme of the Program's Technology Utilization objectives?
- ☐ 1.2 What is the relative value of this technology among the program's total set of technologies, in quantitative terms?
- ☐ 1.3 What is this technology's stage of technical readiness for private sector use and transfer? If highly ready, does anything else need to be done to document that readiness to non-Federal actors?
- ☐ 1.4 What "system-level" issues in the potential adopting sector need to be resolved? Are methods in place for handling the anticipated "side-effects" of using this technology?
- ☐ 1.5 What is this technology's state of economic readiness for transfer? What more needs to be done to document its comparative economic advantages?
- ☐ 1.6 What remains to be done regarding the patent and licensing status of this technology?
- ☐ 1.7 What generic types of work remain to be done to encourage the private or non-Federal government sectors to want and to accept this technology?
- ☐ 1.8 What specifically needs to be done to show this technology at its very best advantage relative to competitors?
- ☐ 1.9 Is there concurrence among all concerned that a focused T.T. effort is now necessary/appropriate for this technology?

2. TECHNOLOGY TRANSFER ACTION SPECIFICS

- ☐ 2.1 What is the main objective of this effort (expected accomplishments)?
- ☐ 2.2 Who, specifically, is on the T.T. team for this technology, as managers, planners, operators, and evaluators?

2. TECHNOLOGY TRANSFER ACTION SPECIFICS (Continued)

- ☐ 2.3 What is the main message to be communicated/transferred?
- ☐ 2.4 Who are the specific audiences, i.e., end users, manufacturers, service providers, financiers?
- ☐ 2.5 What characteristics of these audiences are most important with respect to their responding to a T.T. effort and adopting this technology?
- ☐ 2.6 Will the audience respond to technical and economic information only, or does it have to be worked with in special ways to accept the technology?
- ☐ 2.7 What specific T.T. mechanisms will be used in this effort? What are their time frames for execution and expected impact?

3. COSTS AND BUDGETS

- ☐ 3.1 What is the cost of this T.T. effort, expressed in terms of what it will cost industry or localities to evaluate, adapt, and adopt this technology?
- ☐ 3.2 How will this cost be apportioned? To the technology R&D program? To other Federal programs? To other national Governments? To State and local governments? To industry in the form of cost sharing?
- ☐ 3.3 What is the R&D Program's T.T. cost for this technology this year? In following years?
- ☐ 3.4 How will these costs be allocated among explicit T.T. funding and implicit "T.T. charges" to R&D items?
- ☐ 3.5 What contingent costs need to be better understood or budgeted for?

4. TRANSFER ACTION EVALUATION PLAN

- ☐ 4.1 What measurable immediate impacts are expected from this effort?
- ☐ 4.2 What measurable impacts are expected six months later, and one to two years later?
- ☐ 4.3 Who will measure and report those impacts?

Note: See Section 7.12 regarding how the contents of planning at this level can feed into a final evaluation of the effort.

7.10 What must the T.T. agent consider in the planning of an operational T.T. effort?

- A. Here is a checklist of the things the T.T. agent must or should consider when planning a specific effort. It is presented as a form that an agent might use for initial planning, or for seeking approval of a developed plan.

The items listed here are drawn in part from a Technology Transfer planning form that has been used experimentally in the Department of Energy conservation and renewable energy programs. A form with this many items should usually be spread over about four pages. Not all items are relevant to all programs.

TECHNOLOGY TRANSFER OPERATION PLANNING FORM/CHECKLIST:

1. Organizational Unit:
2. Responsible Agent:
3. Brief Title of Action:
4. Message (What is being transferred?):
5. Audience (Expected users of technology? Be as specific as possible.):
6. General Objective (Expected measurable result?):

7. T.T. Team (Who needs to be involved?):

Skills needed: Goal, Level of Effort (Person months)

Researcher

Writer

Spokesperson

8. Coordination Agreements with Other Organizations:

9. Transfer Mechanisms (See Mechanisms List, Section 7.13):

10. Rationale for Selection of T.T. Mechanisms:
11. Audience Input (How target audience helped plan this effort?):
12. Impacts on R&D Efforts (What changes in R&D direction would facilitate this technology transfer effort? How necessary are these changes?):
13. Budget (\$ Cost to Government; \$ Cost-Shared.):
14. Previous and Estimated Future Budgets for this Effort:
15. Major Milestones (For higher-level planning & reporting):
16. Assignments, Time Table for Actions:
17. Evaluation (How will you measure/report immediate impact?):
18. Evaluation (How will you measure/report later impacts, i.e., six months to one year and later?):
19. Approvals:

Title:

Signature:

Date:

etc.

7.11 What must a Technology Transfer Program manager do to integrate many tactical T.T. efforts into a coherent whole?

- A. This is often a difficult issue to solve, for two reasons. But useful approaches exist.**

First, the lead actions of a Technology Utilization (R&D) program are often driven by a combination of technology breakthroughs and politically-mandated objectives. Explicit T.T. initiatives are often "tacked on" to the program to solve problems identified in a year to year time frame.

Second, it is often hard to predict or measure "quantitative" benefits of specific T.T. projects. While costs of T.T. projects can usually be identified, the benefits basis of a "portfolio" approach to T.T. investments is shaky.

Nevertheless:

- * The intensity (i.e., budget) of a specific T.T. project should match (be somewhat proportional to):
 1. The technology's readiness for transfer
 2. The apparent importance of the transferred technology to the Program's overall objectives
 3. The size of the audiences to be affected, and
 4. The perceived difficulty of convincing the audiences to adopt the technology, i.e., specific resistances to be overcome.
- Reporting must be maintained as current as possible:
 1. Sideways, to R&D project managers
 2. Upward, to higher level decision makers
 3. Downward, to field agents, and
 4. Outward, to potential adopters and industry partners.
- * Out-year plans and resource requirements should be worked out to at least three to five years, since it almost always takes two years to generate any necessary major shifts in budget programming.

One useful integration tool is a planning/reporting matrix like that on the next page. The intent is to maintain realism with respect to technology transfer needs and initiatives. It is most useful to maintain as a computerized database or spread-sheet, from which public reports can be generated as needed.

A PROGRAM T.T. INTEGRATION/REPORTING MATRIX

TECHNOLOGY SPECIFIC OR SOCIAL NEED FOCUS	T.T. PROJECT	T.T. PROJECT ACTORS	GENERIC RATINGS(a) MODE OF PROJECT R _x V _x S _x D=Total	NEED (\$ 000s) FY86 FY87 FY88 FY89
--	-----------------	------------------------	---	---------------------------------------

1. Portable Generators

1.1 Tech/Econ Assessment	4 4 3 2	96	50	10	
XYZ Lab Analysis					
1.2 Distribute Assessment	5 4 3 2	120		30	60
XYZ Lab Broadcast					
1.3 Evaluate Progress	5 4 3 1	60		10	20 10
EVV, Inc Survey					

2. Boiler Replacement

2.1 Technology Verification/Demonstration					
SSS, Inc Demo	5 5 5 4	500	2000	2000	1000 500
Cost Share: (QVP, Inc.)			3000	4000	3000 1000
2.2 International Agreement	5 5 5 1	125			
ABC Lab Broadcast					50 100
Cost Share: (Rpbl. of Ouzu)				1000	1000

... Other Items

9. Industry Review Panel (Constituency Building)

9.1 Annual Meeting	5 2 2 3	60	30	31	33 35
ABC Lab Planning					

TOTALS:

A. Program-Specific Budget/Outlay;	3400	3200	2030	2200
B. Cost Shared:	4200	4500	5210	1700
C. Grand Total:	2800	7600	7700	7240 3900

- (a) Note: A five point scale is used here, for each of:
 R = Readiness for transfer, V = Value re Program's objectives,
 S = Size of audience, D = Difficulty to convince audience.

Additional useful information, could include: Previous year outlays, Row totals for each project and functional area, Major audience identification, Lab/Industry/-University/Other funding splits, Ratio of budget (Need) to Rating. Some of these items can be generated as reports from a database, rather than carried as explicit data entries.

It may also be worth noting that projects with very large budgets (e.g. extensive field tests, demonstrations) can distort the program perspective on smaller specific T.T. efforts. Large projects are often administratively separated from small ones, for this reason, among others.

7.12 Evaluation Check List

This section presents issues to be considered in the evaluation of ongoing and completed T.T. efforts.

Evaluation, during the progress of the effort and after its conclusion, should be linked to the measurable goals identified out in the T.T. "Tactical Plan" (Part 4 of the Checklist in Section 7.9). However, evaluators of Federal R&D and service programs point out that unanticipated effects (positive and negative) are as common as planned-for and anticipated effects.

EVALUATION FOCUS QUESTIONS:

- * What was the goal of this effort? Did it change? Why?
 - * What was the initial plan of action? Did it change? Why?
 - * What, in fact, was done with respect to this need or effort?
 - * How much was spent, on what, in what years?
 - * Did the effort proceed roughly as originally envisioned?
 - * If the effort is in progress:
 - Are its goals and objectives still valid, or has the programs whole moved beyond them?
 - Is redirecting needed to ensure meeting the objectives?
 - * What unexpected events or reactions occurred, and how were they handled?
 - * What measurable effects actually occurred? What "percentage" of the original goals did the effects attain?
 - * What unanticipated benefits (or setbacks) occurred?
 - * What still remains to be done with respect to transferring this technology?
 - * What needs to be done to alert others to the success or failure of this type of technology transfer effort?
-

USEFUL OUTPUTS OF EVALUATIONS

- * List of T.T. "Process" efforts
 - * List of Technical Reports, Handbooks
 - * List of Cost, Economics, Market analyses
 - * Market development statistics and analyses
 - * List of Audiences reached
 - * Membership lists of industry associations, engineering society specialty groups who are interested in the technology
 - * List of known adopters, for referrals on technology performance, etc.
 - * Notices of recognition of technology:
 - Awards
 - Certifications
 - Patents, licenses
 - * List of negative reactions, squeaky wheels, continuing resisters, problem areas
 - * "Success stories", packaged for industry, government
-

7.13 Technology Transfer Methods Checklists

Some technology transfer mechanisms are listed here as reminders of means that have been and can be used to transfer technology to industry, and to sustain and enhance operations of T.T. programs.

MEDIA/PRESENTATION MECHANISMS

Annual Meeting
Billboard
Briefing
Brochure
Clearing House
Conference
Data Bank
Direct Mailing
Education Course
Exhibit
Industrial Trade Fair
Lecture
Liaison with Industry
Association
Loop Film/Tape
Magazine, Popular
Magazine, Technical
Motion Picture
Newsletter
Newspaper
Release
Feature Article
Advertisement

One-on-one
Poster
Radio
Spot Announcement
Interview
Prepared Program
Repro Master
Seminar
Slide/tape Program
Speech
Symposium
Technical Report
Telephone
Television
Spot Announcement
Interview
Prepared Program
Video Tape
Workshop

INFORMATION-DEVELOPMENT MECHANISMS

Case Study
Cost Analysis
Demonstration
Facility
Process/Procedure
Design Competition
Economic Analysis
Feasibility Study
Hearing
Industry Review Panel
Market Analysis
Market Penetration Analysis

Planning Session
Program Plan
Progress Monitoring
Project Review Visits
Questionnaire
Standards
Consumer Product
Engineering
Measurement
Technical Assistance
Tele-conference
Telephone Survey

INCENTIVES TO INDUSTRY/UNIVERSITIES

Construction Grant
Contract
Cooperative Project
Cost Sharing
Equipment Purchase/Donation
Feasibility Study, Subsidized
Fellowship/Scholarship
Grant
Initial Product Purchase, Buy In
Jointly-Funded Project
Lease, Minerals
Lease, Public Sites
Liability Limits

Loan Guarantee
Loan Subsidy
No-Cost Leasing of
Federal Plant
Patent
Patent License, (Exclusive)
Personnel Loan
Price Support
Regulation
Reinsurance Support
Standards, Federal
Tax Credit
Testing of Products, Federal

T.T. ORGANIZATIONAL INCENTIVES

Awards
Bonuses
Directives
Mandates
Personnel Loan to Industry
Personnel Loan from Industry
PPBS Requirements

Promotion
Recognition
Reorganization
Reporting Standards
Team Building Efforts
Travel

OTHER

Data Swaps
Government Interagency Agreements
International Agreements
International Conferences
Technical Exchanges

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TO: DIRECTOR, FBI (100-442611) FROM: SAC, NEW YORK (100-100000)

SUBJECT: JAMES EARL RAY, AKA; MURDER OF MARTIN LUTHER KING, JR.;
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RE: NEW YORK TELETYPE TO BUREAU, 1/14/78.
RE: NEW YORK TELETYPE TO BUREAU, 1/13/78.
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8.0 INFORMATION RESOURCES

- 1. What is information?**
 - 2. How is information organized?**
 - 3. How does one access information?**
 - 4. How does information impact the technology transfer process?**
 - 5. Resource Networks.**
-

GUIDE TO SECTION 8.0

Section 8.1 defines information and the generation process

Sections 8.2 and 8.3 describe its organization and accession

Section 8.4 describes the utility of information in the technology transfer process; and

Section 8.5 highlights the organized systems for resource identification.

8.1 What is "Information"?

- A. Our definition of information is: "the accumulation of knowledge on a subject."**

The real value of information lies in the degree it can be applied. The efficient use of information thus requires more than just collection of data and its dissemination.

Since the Industrial Revolution, manufacturing has been the mainstay of the economic process. During the 1970s and 1980s there has been a shift from an industrial-based economy in the U.S. and other industrialized nations to a more information-based economy. This economy is based upon the generation, transmission and application of information. For example, education, data processing, telecommunications, insurance, medical care, and technology transfer are all industries supported by information technologies such as computers, electronics, and satellites.

This shift has been the result of the most massive period of information generation ever witnessed by mankind. Many factors have contributed to this growth:

- increased R&D expenditures
- an increase in worldwide educational attainment
- the increased availability of computers and telecommunications equipment; and
- increased emphasis on technology transfer.

The general availability of low-cost, powerful computers has changed the way information is stored and retrieved. The present-day technology transfer library tends to be electronic. Worldwide generated information is collected and stored in a computer data base, then accessed through a computer terminal. A user feedback loop is incorporated in the process, thus making the electronic system dynamic and current.

Most information still exists in printed form. However, in just a few years, the amount of information available in electronic form now exceeds 4,000 data bases, each of which contains hundreds of thousands of records of information. Information is the motor that drives the technology transfer process, and computer access to worldwide resources has become the tool of the transfer specialist.

INFORMATION GENERATION

8.2 How is Information Organized?

The traditional approach to organizing information has been in the form of written reports, compiled in books and journals. With the advent of the computer, it has become possible to transform the written word into an electronic form and store it within the computer.

The generation and storage of information follows a sequential process. Information is generated by a researcher who writes a report. This report is then published in the traditional print media (e.g., book, journal, or special document). This document is then reviewed by a professional abstractor, who extracts salient features and creates a concise abstract. As shown in the example, the abstract contains the author, the institution, major and minor key words, text availability, and a brief citation of content. This type abstract is then stored in an electronic data base. Most data bases only contain abstracts or citations rather than the complete text. The retriever can rapidly review abstracts, and then select and acquire the full-text documents for thorough analyses.

The translation of knowledge generated by others can lead to significant changes in the content and meaning of a report. Thus, the abstractors' job is a critical one. To facilitate the process and to enhance retrieval, a sequence of "key words" (see the MAJS and MIMS entries in the example) is generated for each document. These are developed from lexical statistics (number of times a word/-phrase is repeated) and phrases of perceived technical significance. To standardize the key words, several thesauri have been formulated. These are comprehensive compilations of key terms. For example, the DOE thesaurus contains over 25,000 terms covering all aspects of energy related research. Quite often, these thesauri are also numerically indexed by major subject areas and sub-indexed to specific topics similar to that done for industry (i.e., Standard Industrial Classifications (SIC) codes). The most commonly utilized thesaurus is that developed by the National Science Foundation.

The information stored within a computer is also organized in different formats, better known as "indexing." These index schemes permit more efficient retrieval by allowing logical operations to be performed by the computer. For example, to find all citations written by a certain author on a specific topic, use of the logical AND will reduce the number of citations the searchers will have to review to find the one of specific interest.

With the rapid advances made in computer technology, the information that may now be placed in a computer has been tremendously expanded. Initially, only professionally prepared abstracts of the most relevant articles in critical journals were stored. Gradually, this has shifted to incorporation of most periodicals. Now it not only includes reports, but also directories (e.g., electronic yellow pages), human resources (e.g., university faculty and technical expertise), and current events such as the Dow-Jones stock averages. The next table gives brief descriptions of several commercially available data bases.

Although universal standards for abstracting and storage do not exist, standardization is gradually occurring, and will allow non-specialists direct access to worldwide information through the computer.

DATA BASE EXAMPLES

Data Base	Description	From	Records
RECON	NASA & Aerospace Reports	1962	2,200,000
COMPENDEK	Engineering	1970	1,415,000
INSPEC	Electrical Engineering	1969	2,494,000
NTIS	Government Technology	1964	1,122,000
SAE	Automotive & Aeronautical	1965	16,000
WELDASEARCH	Welding Technology	1967	76,500
CA SEARCH	Chemistry & Chemical Eng.	1967	6,840,000
RAPRA Abstracts	Rubber & Plastics	1972	220,000
Ceramic Abstracts	Ceramics	1980	35,000
METADEX	Metals	1966	596,500
Corrosion	Corrosion Data	Curr	2,400
Materials Business	Economics about Materials	1985	10,000
Claims US Patents	U.S. Patents	1950	220,500
World Patents Index	World Patents	1981	3,000,000
JAPIO	Japanese Patents	1976	1,500,000
TRADEMARKSCAN	U.S. Registered Trademark	1884	36,000
RAPRA TRADENAMES	Plastics Tradenames	1976	15,000
DOE Energy	Energy	1974	1,470,500
Energyline	Energy Issues & Problems	1971	54,800
Energynet	Energy Directory	Curr	2,750
CURR BIOTECHNOLOGY	Biotechnology	1983	11,000
MEDLINE	Medicine	1966	4,687,000
Life Science	Life Science	1978	730,000
AGRICOLA	Agriculture	1970	2,826,000
CAB ABSTRACTS	Agriculture	1972	1,760,000
FOOD SCIENCE & TECH	Food Technology	1969	381,000
COMPUTERPAT	Computer Patents	1942	7,500
COMPUTER DATABASE	Computers	1983	36,000
PTS PROMT	Industry Market & Tech.	1972	878,500
PTS DEFENSE MARKETS	Defense Industry	Curr	70,900
PTS U.S. TIMES	Market Data	1957	126,300
ASI	U.S. Government Statistic	1973	9,600
HARVARD BUSINESS REV	Management	1971	2,500
ARTHUR D. LITTLE	Forecast & Planning	1977	680
STANDARD & POOR'S	Public & Private Corp.	Curr	45,000
MOODY'S CORP PROFILE	Info. on Public Companies	Curr	3,600
ELECTRONIC YELLOW PG	Manufacturer's Info.	Curr	504,000
D&B Mill. Dollar Dir.	Large Company Information	Curr	115,000
D&B DUN'S MARKET	Company Information	Curr	1,960,000
DIR OF AMER RES & TECH	R&D Company Information	Curr	11,000

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UTTL: Institute for Materials Science and Engineering,
Ceramics: Technical activities, 1985

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CORP: National Bureau of Standards, Gaithersburg, Md. CSS:
(Inst. for Materials Science and Engineering.)

SAP: Avail: NTIS HC AO5/MF AO1

CIO: UNITED STATES

MAJS: /*CERAMICS/*CHEMICAL REACTIONS/*MATERIALS HANDLING/*,
MECHANICAL PROPERTIES/*OPTICAL PROPERTIES/*STRUCTURAL
STABILITY

MINS: / BIOPROCESSING/ COMPOSITE MATERIALS/ GLASS/ HIGH
TEMPERATURE/ POWDER (PARTICLES)/ TRIBOLOGY

ABA: GRA

ABS: The report of the Institute for Materials Science and
Engineering, Ceramics: Technical Activities 1985,
contains the following: Properties/performance,
Mechanical properties; Glass and composites;
Tribology; Optical properties;
Structure/stability-High temperature chemistry;
structural chemistry; Ceramic powder characterization;
Surface chemistry and bioprocesses;
Processing-Structural science; and Ceramic chemistry.

INFORMATION GENERATION AND ELECTRONIC STORAGE PROCESS

8.3 How is Information Accessed?

The first recorded approach to storage and accessing of electronic data was done by the National Library of Medicine. A medical index was formulated and utilized to produce the Medical Literature Analysis and Retrieval System (MED-LARS). Following their lead, NASA, as part of its technology transfer mandate, developed an electronic data retrieval system known as REMote CONsole (RECON). This became the first comprehensive on-line retrievable system that had widespread utilization.

Access to an electronic data base is done through a computer terminal. It may be through a specialized terminal directly connected to the host computer system, or it may be one remotely connected through electronic interconnects (modems). With the advent of personal computers (PCs), almost all terminals are now PCs. In general, a technology transfer workstation configuration contains a PC, a modem, and a printer.

No specific type of PC is required, although the unofficial standard is the IBM XT or a clone. An XT configuration of 640K RAM (memory) with a 20 MB hard disc is sufficient to carry out the retrieval process in an efficient manner. The industry standard modem is produced by Hayes. Modems have different features, such as automatic call up, and operate at different transmission rates. For low volume, direct review, a 300 baud rate modem is acceptable. For high volume usage, 1200 or 2400 baud modems should be utilized. Printer selection is solely based upon output quality desired and volume of output. In general, a 300 CPS dot matrix printer is sufficient.

Access to a data base originally was done in "batch" or an off-line mode. A request would be made and queued in the host computer for processing at some later time. Today, many computers permit the real-time processing of requests, that are instantly acted upon by the host computer.

Although computers can carry out numerous operations, millions per second, efficient utilization is still important. Most data bases are still "free text" searched, which means that the computer searches through every document comparing words/phrases with those input by the requestor. To do this efficiently still requires a trained individual known as an "information specialist." In general, every major laboratory now has such a specialist, and it is his or her role to assist individuals to produce strategies to retrieve information.

The search process entails developing a set of key words (i.e., technical subject terms) that are then formulated into a set of logical operations (i.e., the search strategy). The appropriate data bases are selected and accessed. The execution of the strategy produces a number of "hits" (i.e., citations that fulfill the criteria described in the search strategy). If the "hit" statistics are sufficient, the information is either displayed on a computer terminal for review, or is electronically "downloaded" from the data base computer to the local workstation. The electronically recovered results are then reviewed off-line at the workstation by the individual interested in the information.

INFORMATION ACCESS

8.4 How Does Information Impact the Technology Transfer Process?

As described in Section 5.4, innovations are utilized in a variety of ways, surprisingly, the least common of which is incorporation directly as a new product. Thus, technology transfer, for the most part, is the effective transfer of information (i.e., new knowledge).

With the ever-increasing amount of information being generated, it can become overwhelming for the transfer agent. It is essential to define and refine the requestor's real-world need so as to produce the most salient, concise information on the subject areas. The technology transfer specialist is not only the gatekeeper, but also the information manager who maintains the technological "treasures" and also implements management's transfer program.

To successfully carry out the brokerage function requires use of wide-ranging internal and external resources. The resources may be technical information, technical expertise, or actual technologies, and the agent's responsibility is to retrieve and apply them to the transfer process. The proper utilization of information resources is critical to a successful transfer.

The rate of transfer requirements will be increasing with the passage of the Technology Transfer Act of 1986 (P.L. 99-502). This Act formalizes the government's desire to develop effective means for transferring federally generated information to the private sector. This Act was underscored with an Executive Order (Facilitating Access to Science and Technology) on April 10, 1987 calling for improved technology transfer to enhance U.S. industrial competitiveness.

INFORMATION MANAGEMENT

8.5 Resource Networks

The aggregation and transmission of information has generated major industries. In the 1960s, only one or two data bases existed. In the 70s, with the advent of faster, inexpensive computers, more data bases were developed, in particular, by the private sector. By the 1980s, over 4,000 specialized data bases were in existence.

The Federal government has provided resources to develop agency specific data networks. DARPA NET, Technical Information System (TIS), and the Technology Utilization Network System (TUNS) are examples of some of these computerized networks. Individual data bases may be directly accessed through the agency network, or through commercial services such as Dialog, BRS, Mead Data, etc. Because most of the computerized information exists in abstract form, full-text documents need to be accessible. To handle the task, the Federal government formed the National Technical Information Service (NTIS). Any government archived document can be obtained through NTIS. Access can be accomplished on-line through a computer, by phone, by mail, or in person.

The Center for the Utilization of Federal Technologies (CUFT) exists within NTIS. CUFT provides access to most government held patents and maintains directories of Federal laboratory resources, and State and local government resources.

Other resource networks include State university technical resources, specific Federal laboratory technical resources, the NASA dissemination system, the Federal Laboratory Consortium -- and the list goes on. Each of the networks is a combination of human resources archived in computerized data bases and a linker / broker to access the resources.

For the technology transfer agent, these networks provide almost instantaneous access to the world's intellectual base. Access is still difficult, because the resources are disparate autonomous functions operating across the world. Although clearinghouses have been formed, e.g., the NASA Industrial Applications Centers, the DoD Information Analysis Centers, and NTIS, universal linkage does not yet exist. Thus, the agent will be required to expand his universe as widely as possible, through face-to-face encounters and through electronic encounters. The growth of information is continuing unabated, and its organization is occurring at many different levels and many different sectors. The role of the agent is to be able to interlink the resources to solve a specific transfer request.

Training is available from the private sector, and from the Office of Personnel Management (OPM course on Technology Transfer). Again, no universal curriculum exists, although it is under development. Most agents are self-taught.

Professional development occurs through participation in national symposia and through organized societies. Organizations such as the Federal Laboratory Consortium (FLC), the Technology Transfer Society, and the Licensing Executives Societies are a few examples of the organizational resources available for professional development.

Technology transfer specialists are being recognized as key resources in implementing strategies to achieve the goal of developing a technologically advanced society.

RESOURCE NETWORKS

Interaction Model

THE UNITED STATES OF AMERICA

DEPARTMENT OF JUSTICE

INVESTIGATION OF THE ACTS OF VIOLENCE COMMITTED BY THE KKK

IN THE CITY OF MEMPHIS, TENNESSEE, ON APRIL 4, 1968

MEMPHIS, TENNESSEE, APRIL 4, 1968

TO THE HONORABLE ATTORNEY GENERAL

WASHINGTON, D. C.

FROM THE DIRECTOR, FBI

RE: CIVIL RIGHTS - KKK - MEMPHIS

URGENT

4-4-68

TO DIRECTOR, FBI

FROM MEMPHIS

RE: CIVIL RIGHTS - KKK - MEMPHIS

URGENT

4-4-68

TO DIRECTOR, FBI

FROM MEMPHIS

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URGENT

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TO DIRECTOR, FBI

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RE: CIVIL RIGHTS - KKK - MEMPHIS

REFERENCES AND SOURCES

A. GENERAL REFERENCES

These references are recommended as general and technical information for Technology Transfer managers. That some of them might appear to be dated reflects an unusual period in the late 1960's through mid-1970's when Federal agencies, particularly NSF and NASA funded a great deal of research on the Technology Transfer process.

1. Baer, W.S., L.L. Johnson, and E.W. Merrow., Analysis of Federal Demonstration Projects: Executive Summary, RAND Corporation, Santa Monica, California, 1976.
2. Baroco, P.E., "Technology Transfer: What's Acceptable and Why". Security Management, September 1983.
3. Battelle Columbus Laboratory, Interactions of Science and Technology in the Innovative Process, National Science Foundation, Washington, D.C., 1973.
4. Brooks, H., "National Science Policy and Technology Transfer", in Proceedings of Conference on Technology Transfer and Innovation, National Science Foundation, Washington, D.C., 1966.
5. Brooks, H., The Government of Science, MIT Press, Cambridge, Massachusetts, 1968.
6. BRS, "Federal Applied Technology Data Base," Online Access through BRS.
7. Burns, T., "Models, Images, and Myths", in Gruber and Marquis, Eds., Factors in the Transfer of Technology, MIT Press, Cambridge, Massachusetts, 1974.
8. Clark, N., The Political Economy of Science and Technology, Basil Blackwell Ltd., New York, 1985.
9. Davidson, H.F., M.J. Cetron, and J.D. Goldhar, Technology Transfer, Noordhoff, Leiden, 1974.
10. Dean, B.V. and J.D. Goldhar, Management of Research and Innovation, North-Holland Publishing Co., New York, 1980.
11. Denny, J.E., "Cooperative R&D: DOE's Patent Policy Need Not be a Barrier". Research Management, Sept./Oct. 1983.
12. Diebold, John, Managing Information: The Challenge and the Opportunity, AMACOM, 1985.
13. Doctors, S.I., The Role of Federal Agencies in Technology Transfer, MIT Press, Cambridge, 1969.

14. Ezra, Arthur A., "Technology Utilization: Incentives and the Federal Role". In Reference 22, 1984.
15. "Federal Technology Transfer Act of 1986," PL99-502.
16. Foster, Richard N., "Organized Technology Transfer". Harvard Business Review, November/December 1971.
17. GRQ, Inc., Technology Transfer Directory, GRQ, Paoli, PA, 1986.
18. Hetzner, W.A., L.G. Tornatzky, and K.J. Klein, "Manufacturing Technologies in the 1980s: A Survey of Federal Programs and Practices". Management Sciences, Vol. 29, No. 8, August 1983.
19. Herman, J.F., "Refining the Federal Government's Role in Technology Transfer". Research Management, Jan./Feb. 1983.
20. Hough, G.W., Technology Diffusion, Lomond Publications, Mt. Airy MD, 1975 (2nd printing 1983).
21. Huffman, G. David, Technology Transfer Handbook. To be published 1987.
22. James, J.A. and D.K. Kenkeremath, Eds., A Synthesis of Technology Transfer Methodologies: Proceedings of U.S. Department of Energy Technology Transfer Workshop, Division of Geothermal and Hydropower Technologies, U.S. Department of Energy, Report CONF-8405184, December, 1984.
23. Kely, P., et al., Technological Innovation: A Critical Review of Current Knowledge, San Francisco Press, San Francisco, California, 1978.
24. Linhares, A.B., "Technology Transfer", in Reference 33, 1977.
25. Merrifield, D.B., "Forces of Change Affecting High Technology Industries". In Reference 22, 1984.
26. Mock, J.E., "Technology Transfer - An Overview". In Reference 21, 1984.
27. Nabseth, L., and G.F. Ray, The Diffusion of New Industrial Processes, Cambridge University Press, Cambridge, 1974.
28. National Science Foundation, Federal Technology Transfer: An Analysis of Current Program Characteristics and Practices, Report prepared for the Committee on Domestic Technology Transfer, Federal Council for Science and Technology, Washington, D.C., December 1975.
29. North Atlantic Treaty Organization (NATO), NATO Advanced Study Institute on Technology Transfer, Paris-Evry, France, June 1973.
30. Nelson, R.R., and S.G. Winter, An Evolutionary Theory of Economic Change, Belknap Press, Harvard University, Cambridge, MA, 1982.
31. Robbins, M.D., J.A. Kelly, and L. Elliot, Mission-Oriented R&D and the Advancement of Technology: The Impact of the NASA Contribution, Univ.

of Denver Research Institute, Denver, Colorado, 1972.

32. Robbins, M.D., Factors Leading to the Success and Failure of Complex Technology Transfer Programs, EDUCOM, Princeton, New Jersey, 1977.
33. Salasin, J., and Hattery, L.H., Eds., The Management of Federal Research and Development: An Analysis of Major Issues and Processes, The Mitre Corporation, McLean, Virginia, December 1977.
34. U.S. DOC, Directory of Federal Technology Resources 1986-1987, U.S. Department of Commerce, NTIS PB86-100013.
35. U.S. DOE, Energy Data Base Subject Thesaurus, U.S. Department of Energy Technical Information Center, Oak Ridge, TN, 1981.
36. U.S. House of Representatives, Committee on Science and Technology, Sub-committee on Science, Research, and Technology, Hearings on Implementation of P.L. 96-480. The Stevenson-Wydler Technology Innovation Act of 1980, U.S. Government Printing Office, Washington, D.C., 1982.
37. U.S. National Aeronautics and Space Administration (NASA), NASA RECON -- User's Reference Manual, NASA Scientific and Technical Information Branch, Washington, D.C., 1985.
38. Whitaker, R., "EPRI Test Centers: Full-Scale Experience for New Technologies". EPRI Journal, Jan./Feb. 1984.
39. Wright, P., "Technology Transfer and Utilization: Active Promotion or Passive Dissemination?" Research & Development, September, 1966.

B. SOURCES REFERRED TO IN TEXT

INTRODUCTION

"A Synthesis of Technology Transfer Methodologies: Proceedings of U.S. Department of Energy Technology Transfer Workshop". See Reference 22.

Section 2.6

Biological model of technological dynamics. See References 7 and 26.

Section 2.10

Definition of innovation of Dr. Harvey Brooks. See Reference 4.

Section 3.4

Diagrams for Inventing, Informing, Innovating, Integrating models. See Reference 20.

Section 4.2

Explanation and description of Technology Delivery System. See Reference 14.

Section 4.9

Map of industry technology adoption decision process. See Reference 16.

Section 5.1

Data on lead times for technology transfer. See Reference 26.

Section 5.4

Statistics on how transferred technology is used. See Reference 39.

Section 6.8

Diagram of effectiveness of mechanisms in meeting Federal program needs. See Reference 24.

Section 7.10

Technology Transfer Operations planning checklist. Most of the items in this list came from a technology transfer project planning form circulated in 1984, in draft form, at various levels of the Conservation & Renewable programs of the U.S. Department of Energy.

REPORT OF THE COMMISSIONER OF THE GENERAL LAND OFFICE
TO THE SECRETARY OF THE INTERIOR
FOR THE YEAR ENDING DECEMBER 31, 1904

INDEX

Note: References are to Section Numbers.

- Acquisition Agents
 - See: Technology Acquisition Agent
- Active Mode, 3.1, 3.6, 3.7
- Adapting, 2.1, 2.7, 3.7
- Adopter, Adopting, 2.2
 - Definition, 2.4
 - Capabilities, 1.4, 2.3, 2.7, 6.3, 6.7
 - Management of, 1.7
- Anti-Trust, 6.3
- Audiences, 1.1, 1.3, 4.0
 - as Actors, 4.1, 4.8
 - Participation, 7.4
 - Primary, 2.2, 4.0, 5.4, 6.7
 - Secondary, 2.2, 4.4, 5.5, 6.7
 - Size of, 6.7
 - as Systems, 4.1
 - Target, 2.4, 4.0, 4.8
- Awareness, 2.3
- Barriers, 1.4, 2.2, 2.3, 4.5, 4.11, 7.1
- Bottlenecks
 - See: Barriers
- Breakthroughs, 7.9
- Business Cycles, 4.11
- Buy-ins, 3.3
- Champion, 2.2, 3.1, 3.7
 - Definition, 2.2, 2.4
- Checklists
 - Evaluation, 7.12
 - Operational Planning, 7.10
 - Program Integration, 7.11
 - Strategic Planning, 7.8
 - Tactical Planning, 7.9
 - Technology Readiness, 5.7
 - T.T. Agent's, 7.10
 - T.T. Methods, 7.13
- Clearing House, 2.3
- Commercialization, 1.2
- Communications Problems, 1.4, 2.3
- Competition
 - Among Industries, 5.6, 6.2, 7.8
 - Within Government, 6.5, 7.8
 - See: Technology, Competing
- Constituency, 2.2, 6.4, 6.5, 7.4
- Construction Grants, 3.3
- Convincing, 2.7
- Cost Sharing, 3.3
- Demand Pull
 - See: Market Pull
- Demonstrations, 3.3, 6.7
- Department of Energy, 1.1, 1.2
- Department of Commerce, 2.8
- Department of Defense, 1.2, 2.8, 3.1, 6.6
- Diffusion, 2.4, 3.8
- Economic Competition, 2.8
- Economics, 2.3, 4.4, 6.4
 - Costs, 4.11
 - Cycles, 3.9, 6.4
 - Externalities, 4.11
 - Life Cycle Costs, 6.7
 - Profitability, 6.2
 - Risk, 2.3, 4.11
 - Sub-economic Technology, 6.4
- Environmental
 - Studies, 4.4
- Evaluation,
 - Program, 7.9, 7.11, 7.13
 - Technology, 5.0
- Extension Service, 1.4
- Financial Incentives, 1.4, 2.3, 3.3, 4.6
- Feasibility Studies, 1.4, 2.3, 3.3
- Federal Role, 2.3, 3.3, 6.5
- Feedback
 - of Effects, 3.6, 7.5
 - Loops, 3.9
 - of Processes, 3.6, 7.5
 - To Industry, 5.8
 - To R&D, See: R&D Program
- Firm
 - Size of, 6.3
- Futures Casting, 4.5, 7.8, 7.9
- High-Tech, 6.3
- Incentives, 2.3, 3.3, 7.3

INDEX

Note: References are to Section Numbers.

Industry

- High-Tech, 6.3
- Low-Tech, 6.3
- Maturity, 6.3
- Size of, 6.3

Information

- Dissemination, 1.3, 3.3, 5.0, 5.7, 7.3
- Flow, 2.3, 2.4, 2.8, 4.3, 4.6, 4.11, 8.0
- Processing, 2.3, 4.9, 7.13, 8.0
- Providers, 3.6, 5.2
- Restrictions, 2.8, 6.3
- Sources, 5.6, 7.4, 7.13, 8.0
- Uses of, 5.3, 5.4, 5.5, 7.4

Informer, 3.6, 5.2

Innovation

- Definition, 2.4

Innovator,

- Definition, 2.4
- Outlook, 3.7
- See: Technology Developers

Insurance, 3.3

Integration, 3.8, 3.9, 6.8, 7.11

Interagency Agreements, 6.6

Interests, 2.7, 5.6, 7.8

Inventor,

- Definition, 2.4
- Outlook, 3.5
- See: Technology Developers

Japan, 4.8

Learning Curve, 4.11, 6.4

Leases, 3.3

Life Cycle Costs, 6.7

Loan Guarantees, 3.3

Long-Term Outlook, 3.8, 6.4 7.8

Low-Tech Industry, 6.3

Management, 1.4, 7.0

- Functions, 2.2, 2.9, 7.1
- Incentives, 7.13
- Integration, 2.9, 7.3, 7.11
- Levels, 7.2
- Monitoring, 7.5
- Objectives, 6.8, 7.1
- Reporting, 7.5
- Staff Level, 6.6

Management, Continued

- Travel Restrictions, 6.6
- See: Planning
T.T. Budgets

Market

- Analysis, 2.3, 3.3, 4.11
- Penetration, 4.6
- Pull, 2.1, 2.6, 2.7, 6.7
- Size, 6.2

Marketing Skill, 6.3

Matching Technology and Needs 1.3, 2.1, 2.3, 2.5

- Cost of, 3.1

- Risk in, 1.4

Media, 7.13

Mediation, 1.4

Mission, 1.2

Modes, 3.1, 3.4

- See: T.T. Modes

Monitoring, 7.5

NASA, 1.2, 3.1

National Security, 2.8

Needs, 1.1, 2.1, 2.3

"Not Invented Here" Syndrome

- Definition: 2.3
- Impact of: 2.3, 4.9

Passive Mode, 3.1, 3.5

Patents, 3.3

- Licenses, 3.3

Personnel Shifts, 6.2, 6.3

Planning, 7.0

- Functions of, 7.1
- Methodology, 7.5, 7.6, 7.7
- Operational, 7.10
- Strategic, 7.7, 7.8
- Tactical, 7.6, 7.9

Policy

- Goals, 2.3

Price Supports, 3.3

Private Sector, 1.2, 5.6

R&D Consortia, 6.2, 6.3

R&D Program

- Feedback to, 3.1, 5.7, 5.8
- Interaction with, 1.2, 5.6, 5.7, 6.6

Readiness for Transfer

- See: Technology Readiness

INDEX

Note: References are to Section Numbers.

Regulations, 1.4, 3.3

Reinsurance, 3.3

Resistances- See: Barriers

Risks, 4.11

Semi-Active Mode, 3.1, 3.6

Side Effects, 2.2

Social Benefit, - Capture, 2.3, 6.2

Spin-Off, 1.2, 2.3

Standards, 3.3

Strategy, 7.3, 7.6, 7.7

System Integrator, 6.6

Target

- See: Audience, Target

Technical Assistance, 6.2, 6.5

Technical Expertise, 6.2, 6.6

Technical Performance, 1.4

Technology

- Definition, 1.1, 2.4

- Applications, 3.7

- Awareness of Availability, 2.3

- Champion. See: Champion

- Competing, 5.6

- Complexity of, 6.2

- Consumer, 4.3, 6.7

- Consumer-oriented, 6.2

- Costs. See: Economics

- Developers, 2.2, 2.3, 2.4,

- See: Inventor, Innovator

- Development, 2.2

- Diffusion, 2.4, 3.8

- Displacement, 6.5

- End User, 4.4

- Evaluation, 2.3

- Maturity of, 6.2

- Old, 6.2

- Opposers, 2.2

- Private Sector, 5.6

- Producer, 4.3, 5.7, 6.7

- Push, 2.1, 2.6, 2.7

- Readiness (for transfer),
4.11, 5.0, 5.6, 5.7, 6.2

- Checklist, 5.7

- Service Life, 6.2

- Sub-economic, 6.4

- Usefulness, 2.3, 5.3, 5.4,
5.5, 7.10

Technology, Continued

- User, 4.3, 4.4, 6.3, 6.7

Technology Acquisition Agent

- Definition, 2.4, 4.8

- Roles of, 4.8, 4.9, 5.3
5.4, 5.5

- Skill level, 4.9, 4.10, 6.7

- Support of, 4.9, 4.10

Technology Delivery System

- Definition, 4.2, 4.3

- Analysis of, 4.5, 4.7

- Complexity, 4.3

- Examples of, 4.3, 4.4

- Usefulness of, 4.6, 4.7

Technology Transfer

- Definition, 1.1, 2.5

- Budgets, 6.5, 6.6, 7.11

- Credibility, 5.6

- Examples of, 4.4, 4.6, 5.1

- Expense, 3.1

- Management, 2.7, 7.0

- Managers, 2.2

- Mechanisms, 2.7

- Appropriateness, 3.3,
6.0, 6.8

- Examples, 4.5, 4.6

- Lists, 3.2, 3.3, 5.7,
6.8, 7.13

- Modes, 3.1, 3.4, 7.3

- Negative, 2.5, 2.8

- Objectives, 2.3, 6.8

- Policies, 6.5

- Positive, 2.8

- Program Style, 7.3

- Scope of, 2.5, 5.2, 5.7,
6.8

- Strategies, 6.0, 6.4, 6.5

- Time for, 5.1

Technology Transfer Agent,

2.1, 2.6, 4.8, 8.0

- Definition, 2.4

Technology Utilization, 1.2,
1.3

Turn-Key, 6.3

Uncertainties, 4.11