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Wilbur Wright
J. C. Robinson
ATTORNEY

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Filed Dec. 11, 1946 8 Sheets-Sheet 8

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New York

Moving R&D To The Marketplace

A GUIDEBOOK FOR TECHNOLOGY TRANSFER MANAGERS

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To Ray La Sala
With best wishes.
Jed Mock

Moving R&D To The Marketplace

**A Guidebook
For
Technology Transfer Managers**

1993

John E. Mock
U.S. Department of Energy

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Technology Prospects, Inc.

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ARAC, Inc.

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FOREWORD

The United States faces a paradox: Although the acknowledged world leader in scientific discoveries, it lags behind Japan and several Western Nations in the ability to move technological innovations rapidly out of the laboratory and convert 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 the United States has been unable to capitalize fully on the genius and inventiveness of its research and development community. The reasons behind this paradox are many, and involve all levels and sectors in the chain of invention, innovation, production, and commercialization.

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 and the sustained support to move innovations successfully into the hands of industry and ultimately to the consumer. The R&D manager can have a significant impact on the ability of a Nation to transfer leading-edge technology from the laboratory into the international marketplace.

The United States government is the single largest sponsor of R&D. The managers of Federally-funded research and development efforts have a special obligation for ensuring the timely transfer of technology to the private sector marketplace. Indeed the rationale and the justification for government-sponsored non-military R&D are based on the premise of eventual commercial applications of research results. As the stewards of research undertaken for the public's benefit, research managers must ensure that significant benefits flow from Federal research investments in a timely manner. Usually this will occur only if conscious and systematic efforts are undertaken to facilitate the technology transfer process.

Managing a successful technology transfer program requires detailed knowledge of effective technology transfer strategies and methods. This publication provides a broad background in a simple, straightforward manner for everyone interested in the technology transfer process. It is my belief that Moving R&D to the Marketplace - A Guidebook for Technology Transfer Managers will serve as a valuable and handy reference. It demystifies jargon and suggests practical, common sense approaches. It presents a variety of strategies for accomplishing technology transfer and provides clear examples for the reader, as well as an extensive set of checklists and information sources for day-to-day use.

This guidebook will help R&D managers fulfill their important role in improving U.S. competitiveness in the world market. I recommend it highly as a standard reference guide to R&D managers and to decision-makers in both the public and private sectors.

May, 1993

John M. Deutch
Under Secretary for Acquisition
U.S. Department of Defense

CONTENTS

	PAGE
FOREWORD	iii
INTRODUCTION	xiii
1. ORIENTATION	1-1
2. GENERAL CONSIDERATIONS	2-1
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. PLANNING AND MANAGEMENT	7-1
8. INFORMATION RESOURCES	8-1
9. FEDERAL TECHNOLOGY TRANSFER POLICY	9-1
10. LEGAL CONSIDERATIONS IN TECHNOLOGY TRANSFER	10-1
11. TECHNOLOGY TRANSFER FROM RESEARCH TO MANUFACTURING	11-1
12. MARKET AWARENESS, INREACH, AND OUTREACH	12-1
 REFERENCES AND SOURCES	 R-1
ABOUT THE AUTHORS	T-1
INDEX	X-I

QUICK REFERENCE GUIDE

TOPIC	PAGE
-------	------

1.0 ORIENTATION

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
-

2.0 GENERAL CONSIDERATIONS

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
-

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 which mode and mechanism or another is 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

TOPIC	PAGE
8. Once I have detected with whom to work, how can I keep my interactions with these actors clear and simple?	4-16
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 should 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

TOPIC	PAGE
3. Nature and Status of the Industry	6-6
4. External Economic Factors	6-7
5. Political Philosophy of Decision-Making and Perceived National Priorities	6-9
6. Budgetary Constraints and Options	6-10
7. Nature of the Audience	6-12
8. Summary: A Matrix of Mechanisms' Appropriateness	6-14

7.0 PLANNING AND MANAGEMENT

1. Why is the planning process one of the most important tools of technology transfer management?	7-3
2. What are the organizational levels of management and planning typically required for effective technology transfer?	7-5
3. How do planning and management focus and tactics vary with technology delivery system characteristics?	7-7
4. Why is audience (client) participation important in planning technology transfer program activities?	7-9
5. What are the most essential aspects of monitoring and reporting progress from T ² program operations?	7-11
6. What are the steps for planning a T ² program?	7-13
7. What is strategic planning about, and how is it done?	7-15
8. What are some practical "steps" for strategic planning?	7-17
9. What must the T ² Program manager consider in the tactical planning of a Technology Transfer effort?	7-19
10. What must the T ² agent consider in the planning of an operational T ² effort?	7-21
11. What must a Technology Transfer Program manager do to integrate many tactical T ² efforts into a coherent whole?	7-23

TOPIC	PAGE
12. Evaluation Check List	7-24
13. Technology Transfer Methods Checklists	7-26
<hr/>	
8.0 INFORMATION RESOURCES	
<hr/>	
1. What is information?	8-2
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
<hr/>	
9.0 FEDERAL TECHNOLOGY TRANSFER POLICY	
<hr/>	
1. What is the National policy on technology transfer?	9-2
2. What are the key T ² -related laws and Executive Orders?	9-3
3. Is there a lead Federal organization for T ² ?	9-7
4. Are there Department of Energy specific T ² guidelines or directives on technology transfer?	9-8
5. What are CRADAs?	9-9
6. What incentives are there for a Federal technology developer or the T ² manager to champion technology transfer?	9-10
<hr/>	

TOPIC	PAGE
<hr/>	
10. LEGAL CONSIDERATIONS IN TECHNOLOGY TRANSFER	
<hr/>	
1. What are the primary legal considerations regarding technology transfer?	10-2
2. How do intellectual property laws affect technology transfer?	10-3
3. What should the T ² manager know about patent and trade secret law?	10-5
4. What should the T ² manager know about copyright law?	10-12
5. What should the T ² manager know about trademark law?	10-14
6. What should the T ² manager know about antitrust law?	10-16
7. What should the T ² manager know about international and foreign national laws?	10-18
8. What references can the T ² manager refer to for additional information?	10-20
<hr/>	
11. TECHNOLOGY TRANSFER FROM RESEARCH TO MANUFACTURING	
<hr/>	
1. What should the T ² manager know about the production function?	11-2
2. How does the production function fit into the TDS concept?	11-3
3. What are the differences between the defense TDS model and the commercial TDS model?	11-4
4. What are the differences between the "ladder process" and the "incremental innovation process"?	11-6
5. What are the most important points for the T ² manager to keep in mind?	11-9
<hr/>	

12. MARKET AWARENESS, INREACH, AND OUTREACH

1. What is the importance of market awareness?	12-2
2. What processes may be used for market assessment?	12-4
3. How does one conduct a pre-market review?	12-6
4. What is "inreach?"	12-8
5. What are some inreach mechanisms?	12-10
6. What is "outreach?"	12-12
7. How does one do outreach?	12-14
8. What are some resources for awareness, inreach, and outreach?	12-18

INTRODUCTION

Technological advancement is vitally important to the U.S. and world economy today. Federal research and development (R&D) and technology transfer (T²) activities play a key role in this arena, by helping to develop and disseminate useful technologies to non-Federal sources who can use them effectively.

Technology transfer is rarely a simple process. Many individuals 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 activities are frequently under-funded. Their management is often conducted along unclear lines of responsibility and authority.

PURPOSE AND SCOPE

This Guidebook serves as an introduction as well as a refresher for technology transfer managers. It focuses on the question: "What can the Technology Transfer manager do when confronted by complex 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 T² field over the past 25 years, and
- * To remind seasoned managers of times when some of these T² approaches and methods are most useful.

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, health care, and agricultural advances are technologies of this type.

The contents of the Guidebook will be of value to managers in a variety of Federal, State, university and industry 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 addresses 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 T² programs.

ORGANIZATION

This book is organized around eleven primary concepts that structure the eleven 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 Subsections of Sections 1.0 through 3.0 and Section 8.0 are introductory. If you are reading this as a refresher, you may wish to 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. Sections 9.0 through 11.0 have been added to this edition to broaden the Technology Transfer manager's understanding of the complexity of the overall process.

PRIMARY CONCEPTS

- Section 1.0** - At its best, Technology Transfer ("T²", 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 T² 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 T² modes and mechanisms available to the T² 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. T² mechanisms must be sensitive to the different outlooks and interests of everyone involved in the R&D and T² process.

- Section 4.0** - Audiences for T² 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 those specific uncertainties about a technology that will require the T² manager's assistance in resolving.

- Section 5.0** - Some technologies are more ready for transfer than others. Some T² 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 T² often increases 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 T² 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 T² programs. This Section describes a variety of planning functions and tools, and contains Checklists for strategic planning, tactical planning, operational planning at the T² agent level, T² program integration, and T² project and program evaluation. Section 7.13 lists 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 resources identification.
- Section 9.0** - Federal government involvement in technology transfer dates back over a century. Major legislative acts that explicitly mandate and define the Federal role in T², however, have been enacted only in the last thirteen years. These laws, along with Presidential Executive Orders, form the basis of a defined "National Policy" on the transfer of Federally developed or owned technologies to the commercial marketplace. This section summarizes these laws, highlighting those of particular relevance to the Department of Energy, and provides guidance to the T² manager on statutory incentives for the researcher responsible for inventions, innovations, or other outstanding T²-related accomplishments.
- Section 10.0** - The technology transfer manager must be sensitive to the legal ramifications of his technology transfer activities, and be prepared to draw upon the professional knowledge of legal counsel. Legal problems arise in negotiations and drawing up contracts, in providing guidance on tort law (including product liability and safety), in environmental law, in SEC matters, in OSHA law, in antitrust law, in intellectual property law, and in negotiating and implementing international programs. Sections 10.3 through 10.5 provide the technology transfer manager with a brief introduction to the laws protecting intellectual property including patents, trade secrets, copyrights, and trademarks.
- Section 11.0** - The purpose of technology transfer is not the transfer of technology per se: the purpose is to help a firm improve its position in the marketplace through the transfer of technology embodied in a new commercially successful product or service. The T² manager must examine carefully the total technology delivery system, and not focus on only one step in the process (as on a CRADA). Descriptions and differences between the defense TDS and the commercial TDS models, and between the ladder and the incremental innovation processes are presented to help the T² manager in his planning and implementation activities.
- Section 12.0** - Except in rare break-throughs, technology is not the driving force for a successful transfer. The important factor is that, somewhere, there exists an adopter interested in acquiring the technology. This Section describes the concepts and mechanisms for identifying new technological opportunities (inreach), determining the market potential for an opportunity (awareness) and identifying potential adopters (outreach). To assist the T² managers, research methods and motivators to facilitate these processes are also described.

At the end of the Guidebook are References and a brief background on the authors.

1.0 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 Federal programs?
 4. Why should the "Technology Transfer" function be a separate part of the Technology Utilization process or program?
-

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 spinoff 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. Also it is important to keep R&D workers always 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 with a technology "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 1970s Federal analyses of technology transfer approaches came to this same conclusion. That a "technology champion" is very important for successful innovation, is an insight which has always been part of our awareness .

DIFFERENCES IN ORIENTATION

THE "SPIN-OFF" ORIENTATION:

THE "TECHNOLOGY UTILIZATION" ORIENTATION:

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 accrue 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 WITHIN A TECHNOLOGY UTILIZATION APPROACH

2.0 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 problem ("technology push").

In order to increase the socioeconomic benefits from Federally developed technologies, the Technology Transfer Act of 1986 requires an Office of Research and Technology Assistance (ORTA) at most of the national laboratories. The ORTA is in essence a Technology Transfer agent. These agents work actively to facilitate matches between private sector needs and Federal R&D resources.

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. The recent Secretary of Energy Directive provides support for DOE Technology Utilization programs which 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. He may also assist in overcoming economic, legal, institutional, and regulatory barriers hindering entrance to the marketplace.

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:

- * Persons with needs, who might become adopters of technological solutions to those needs
 - * Technology developers, especially scientists and engineers, who need guidance on what is needed or desired and what technology might meet those needs
 - * Many others who are affected by technology development and adoption processes, including:
 - Federal, state, and local regulatory agencies
 - National, state, and local politicians
 - Government program administrators
 - Potential investors and lenders
 - Potential opposers of the technology
 - Potential adopters 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 Federal inventors and users. Some are philosophical, such as providing U.S. citizens with further returns on their tax dollars.
-

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 a new idea and reduces it to practice.
 3. Innovator: The person or firm who takes technology to commercial use.
 4. Innovation: What the innovator does as process. Also erroneously 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 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 (Broker): A person who matches inventors and their inventions to potential users, and assists the two parties in adapting the invention 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.
 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 objects.
-

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.
 - * "Technology transfer" is sometimes viewed as synonymous with economic development and enhanced industrial competitiveness.
 - * "Technology transfer" is a means to technological literacy.
 - * "Technology transfer" is a technological solution controlled by sociological processes.
-

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 microcomputers 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 regularly 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 1960s, as Federal technology transfer agents became aware that much electronics and materials technology 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-1960s 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 some experts. 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.

In general Federal laboratories still tend to operate in a technology push mode as the majority of their work is mission oriented and technology transfer (rather than utilization) is the prime imperative. With the advent of Cooperative Research and Development Agreements (CRADAs) there is a modest shift to the development of market driven technology.

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 technology adopter 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.

Federal policies dealing with negative technology transfer are currently under review to reflect changed and changing international political realities. However, technologies with potential national security or economic interests (such as computers, surveillance instrumentation, and nuclear technology) will continue to be controlled from transferring to certain foreign nations. 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 mechanisms well enough to integrate them into a system;
 - * Understanding your R&D Program's potential adopter audiences as both systems and individuals;
 - * Discerning the readiness of technology for application to different uses;
 - * Selecting appropriate technology transfer modes and mechanisms;
 - * Being aware of potential resources and rewards;
 - * Publicizing the activity for continuing support;
 - * Establishing and utilizing metrics to evaluate the program; 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 TRANSFER 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 and 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 viewpoints of various individuals 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 transfer 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 far the least expensive, and the least effective. It places most of the transfer work on the shoulders of the potential adopter. The 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 avoid the costs of repeating the same search for technology. The transfer agents may have 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 transfer 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 know 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.

SOME TECHNOLOGY TRANSFER MECHANISMS

- * Intergovernmental Agency Agreements
 - * Personnel Transfer to and from Industry
 - * Joint Government - Industry Development
 - * Government Development / Joint Testing
 - * 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
 - * Informal Interactions
 - * Liaison with Industry Associations
 - * Publications
 - * Information Dissemination Centers
 - * Data Banks
 - * Direct Mailing
 - * Media Announcements
 - * Patents
 - * Licensing
 - * Industrial Shows, Exhibits, and Trade Fairs
 - * Federal Work for Others
 - * Use of Special Federal Facilities
-

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, formerly of the National Science Foundation.
-

1. Federal Procurement 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 is the easiest way to determine which mode and mechanism or another is 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 described in the next few pages.

Each of the models depicts the technology transfer process from the point of view of a different individual 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.

The key individuals involved in these models are:

<u>MODEL</u>	<u>INDIVIDUAL</u>
Inventing	Inventor
Informing	Inventor Technology Transfer Agent Adopter
Innovating	Adopter
Integrating	Adopter Technology Transfer Agent

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 individual 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 an improvement of an existing production device or process by an adopter. 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 publications.

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 a saleable technology. His work usually consists of:
1. Transforming a prototype technology to the point where it fits a market need and will be purchased by customers, and/or
 2. Transferring the technology from the development laboratory to the production and market environments.
-

The Innovator usually requires technical and 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 this potential.

Innovation rarely succeeds unless it is coupled with continual 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 biotechnology 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, social and physiological 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 invention if 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 requires 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 novel 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, formerly 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 TDS 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 GEOTHERMAL HEAT PUMPS 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 geothermal heat pumps 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 Public Utility Commissions) all affect how goods, information, and money flow through the TDS.

LEVELS OF COMPLEXITY IN TDS

1. HORSESHOES

2. RAILROAD BOXCARS

3. GEOTHERMAL HEAT PUMPS

4.4. Show a typical Technology Delivery System.

A. One conception of a Technology Delivery System for geothermal energy 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 determine whether or not it 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 power conversion engineers to improve materials, components, and system performance 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 guide financiers establishing effective lending relationships for this technology.
 - * Support to 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 the target 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, including intermediaries (brokers) knowledgeable in the business area, 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.
 4. Incorporate feedback and experience throughout the development and execution of a TDS.
-

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 envision 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 T² 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. T² program collects and repackages system cost analyses for existing drilling devices.
 2. T² program helps design engineers gain access to information on drillability of particular geological formations.
 3. T² program serves as the information repository and clearinghouse for technical information on interactions of geothermal brines with specific industrial materials.
 4. T² program helps manufacturers of tubular goods gain access to data on performance of products in various applications.
 5. T² program cost-shares project to develop a well-design optimization computer code.
 6. T² program holds symposium of drillers and engineers to collect evolving "rules of thumb" for well design.
 7. T² 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. T² 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 are 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. Others are designed to influence the "mixed" American economy. Review the incentives listed in Section 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 technology and patent reviews
- * Promote
- * Sponsor Federal internships at Labs and Headquarters
- * Keep relevant members of Congress informed.
- * Attend appropriate meetings, conferences, etc.

4. DON'T IGNORE "SECONDARY" AUDIENCES

These include:

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

FOUR KEY FACTORS

4.8 Once I have detected with whom to work, 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 transferring.

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 (or lease) 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 and high developmental costs.
- * A firm may be able to reduce the time-to-market by acquisition or license.

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. Many of these agents are attorneys and are members of the Licensing Executives Society (LES).

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 adopting firm's technology acquisition awareness, interest, and capabilities.

TECHNOLOGY ACQUISITION PROCESS

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 who 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 T² 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 designed to reduce the most important uncertainties for this Technology Delivery System in general?
 - * Are we communicating our new information in a way that reduces the real uncertainties of specific Technology Acquisition Agents?
 - * Have we addressed/reduced bureaucratic entanglements for the TDS?
-

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 the Current Business Cycle?
-

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 begin 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, especially in the U.S. This is due in part to failure on the part of inventors to work closely with marketing function early in the innovation process.
- * The program manager's tenure is often shorter than the lag times. He must be a 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 Know-How
- 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 KNOW-HOW:** A personal ability to apply technology described by information or data to a particular situation. This can involve transfer of people or knowledge 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 found that firms incorporated new technology in the following ways:

<u>% OF</u>	<u>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

(Reference 39)

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

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
 - * Identifying other potential applications for the technology
 - * Maintaining communications with all actors in the innovation process
-

"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 technology transfer. Any technology is really ready for transfer only 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.

The T² program should 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 hand, 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, in general, is going on, 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 to identify "dual" use technologies. 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. Stay in touch with the marketplace.
 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

5.8 What should be transferred at each stage of development?

A. See the exhibit 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
 - * Essential know-how
 - * 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.
 3. Technology Transfer is a continuous not a discrete process.
-

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 next 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. In addition, cyclical economic factors also 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 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 someone 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. 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 in increments. 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 1993 the most severely limiting aspect of geothermal technology appears to lie not in mechanical performance or cost, but 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, Federal and state technical assistance programs, 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 or an incubator 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 actors 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 and private firms.

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 to the inventor, 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 are 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 nor always have the technical capability to carry out the innovation. 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 1970s.

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 wind turbines, 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

Federal 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 of the technologies will cause economic harm to another owner of resources or equipment. Which should win out, or receive relatively more Federal support?

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 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.

The 1990s should be the decade for technology transfer. With the economic downturn, political pressure for greatest use of Federal technologies should be up. This support may not be financial, however, but increased expectations. It is a relatively safe bet that during the 90s government and industry will be measured on the effectiveness of their transfer efforts.

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 technology-oriented and market-oriented experts.

B. Wide fluctuations in budgets

Active T^2 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 in your efforts. They will have to switch to a more active stance 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, three 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.
- * Network whenever and however possible.

D. Fund T^2 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^2 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 your field technology transfer agents have sufficient funds to travel, and make sure that they actually use them for face-to-face work. Remember the adage, "Technology Transfer is a contact sport."

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, 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 adopters, 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 marketing
- * 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 entice 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 Summary: A Matrix of Mechanisms' Appropriateness

- 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 T² 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 ORGINS & 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

7.0 PLANNING AND MANAGEMENT

1. Why is the planning process one of the most important tools of technology transfer management?
 2. What are the organizational levels of management and planning typically required for effective technology transfer?
 3. How do planning and management focus and tactics vary with technology delivery system characteristics?
 4. Why is audience (client) participation important in planning technology transfer program activities?
 5. What are the most essential aspects of monitoring and reporting progress from T² program operations?
 6. What are the steps for planning a T² program?
 7. What is strategic planning about, and how is it done?
 8. What are some practical "steps" for strategic planning?
 9. What must the T² Program manager consider in the tactical planning of a Technology Transfer effort?
 10. What must the T² agent consider in the planning of an operational T² effort?
 11. What must a Technology Transfer Program manager do to integrate many tactical T² efforts into a coherent whole?
 12. Evaluation Check List
 13. Technology Transfer Methods Checklists
-

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 T² program and project planning, and T² program integration.

Sections 7.12 and 7.13 present "reminder" checklists of T² evaluation questions and T² mechanisms.

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

A. For four 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.
 4. It enables the development of a strategic T² Action Plan.
-

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, 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
 7. Ascertain transfer benefits.
-

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 T² team(s) to review progress * Formal written plans, M.O.U.s * Sign-off on agreements * Designated T² 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 T² 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 T² allocations 	<ul style="list-style-type: none"> * Specify measurable objectives for R&D program and T² 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 T² budgets somewhat blurred * Modulate T² 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 and state programs and the latter with the private sector.
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. His overall responsibility is the Program's general T² activity effectiveness in an annual time-frame. The activity emphasis is on:
(1) designing, monitoring, and controlling the overall T² activities of the Program,
(2) ensuring that information on user needs for technology adaptation, gathered by T² operations staff, is communicated to the Program's R&D managers, and
(3) preparing the management reports on the T² 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, T² 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 T² 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.

T² MANAGEMENT/PLANNING LEVELS/RESPONSIBILITIES

1. T² FIELD AGENTS - OPERATIONAL PLANNING

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

2. T² PROGRAM MANAGER - TACTICAL PLANNING

- * General coordination and monitoring of T² agents' operations
- * Integration of market intelligence
- * Allocation of T² effort among specific modes and mechanisms
- * Allocation of T² 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 on R&D program changes that could accelerate T²
- * Monitoring of Program's general T² effectiveness
- * Timely preparation of technical and management reports regarding Program's T² initiatives, budgets, results, costs, etc.

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 T² efforts, in context of overall R&D Program goals and budgets
 - * Response 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. (5) National Technology Transfer Center -- 800 Hotline.

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/adapters -- 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-ARPA 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.

T² 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 aligned 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 T² 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 T² 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 1993, 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 T² budget was spent, and how many people were contacted.
 - * Effects Feedback - Detection and reporting of successes and failures in highlighting the action by technology adopters. Examples: "Program-developed drilling fluids were used in 82 percent of the 35 hot water geothermal wells drilled in 1993", "430 new cogeneration units went on line in 1993."

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 T² program can fund industry "technical analyses" of technology status and R&D needs.

- * Reports from R&D managers and T² agents. Did X in fact adopt technology Y? Or, has technology Y ever been adopted? For example, ask R&D managers for T² 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 1993? You might try to include a requirement to report annual production or sales.
- * Feedback from cooperative R&D (CRADA) efforts.

PROCESSES REFLECT COSTS

EFFECTS INDICATE BENEFITS

- * 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 T² program?

- A. There are two parts to planning a T² program -- strategic and tactical. Strategic plans drive the long range, say two to five-years, 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 T² 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.

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.

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 keystone in these analyses.

STEPS IN TACTICAL PLANNING

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.
6. Analyze the uncertainties and the return on investment. Design a process to measure outcome.

THE STRATEGIC ARENA

STRATEGIC PLANNING TOOLS (Continued):

7. 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.
8. 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.
9. 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 strategies require 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.

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 BUSINESS/NATURE OF PROGRAM TO PUBLICIZE

- * 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 - can be delegated, 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 T² 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 T² 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 T² team for this technology, as managers, planners, inventors, 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 T² 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 T² 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 T² 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 T² cost for this technology this year? In following years?
- ☐ 3.4 How will these costs be allocated among explicit T² funding and implicit "T² charges" to R&D items?
- ☐ 3.5 What contingent costs need to be better understood or budgeted for?
- ☐ 3.6 What incentives will be utilized?

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 T² agent consider in the planning of an operational T² effort?

- A. Here is a checklist of the things the T² 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. T² 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 T² 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. Incentives (i.e. royalty allocation)
16. Major Milestones (For higher-level planning & reporting):
17. Assignments, Time Table for Actions:
18. Evaluation (How will you measure/report immediate impact?):
19. Evaluation (How will you measure/report later impacts, i.e., six months to one year and later?):
20. Approvals:

Title:

Signature:

Date:

7.11

What must a Technology Transfer Program manager do to integrate many tactical T² 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 T² 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 T² projects. While costs of T² projects can usually be identified, the benefits basis of a "portfolio" approach to T² investments is shaky.

Nevertheless:

- * The intensity (i.e., budget) of a specific T² 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 and nature 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. Outward, to potential adopters and industry partners
 2. Sideways, to R&D project managers
 3. Upward, to higher level decision makers, and
 4. Downward, to field agents.
 - * Out-year plans and resource requirements should be worked out to at least three to five years, since it almost always takes one to two years to generate any necessary major shifts in budget programming whether in the government or in large firms.
-

7.12 Evaluation Check List

- A. This section presents issues to be considered in the evaluation of ongoing and completed T² efforts.

Evaluation, during the progress of the effort and after its conclusion, should be linked to the measurable goals identified in the T² "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?
 - * How was the feedback obtained? Formally? Informally?
 - * 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 program as a 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 anticipated and 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?
 - * What was learned from the effort?
-

USEFUL OUTPUTS OF EVALUATION

- * List of T² "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

- A. 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 T² programs.

MEDIA/PRESENTATION MECHANISMS

Annual Meeting	One-on-one
Billboard	Poster
Briefing	Radio
Brochure	Spot Announcement
Clearing House	Interview
Conference	Prepared Program
Data Bank	Repro Master
Direct Mailing	Seminar
Education Course	Slide/tape Program
Exhibit	Speech
Industrial Trade Fair	Symposium
Lecture	Technical Report
Liaison with Industry	Telephone
Association	Television
Loop Film/Tape	Spot Announcement
Magazine, Popular	Interview
Magazine, Technical	Prepared Program
Motion Picture	Video Tape
Newsletter	Workshop
Newspaper	
Release, Feature Article, Advertisement	

INFORMATION-DEVELOPMENT MECHANISMS

Case Study	Planning Session
Cost Analysis	Program Plan
Demonstration	Progress Monitoring
Facility	Project Review Visits
Process/Procedure	Questionnaire
Design Competition	Standards
Economic Analysis	Consumer Product
Feasibility Study	Engineering
Hearing	Measurement
Industry Review Panel	Technical Assistance
Market Analysis	Tele-conference
Market Penetration Analysis	Telephone Survey

INCENTIVES TO INDUSTRY/UNIVERSITIES

Construction Grant	Loan Guarantee
Contract	Loan Subsidy
Cooperative Project	No-Cost Leasing of Federal Plant
Cost Sharing	Patent
Equipment Purchase/Donation	Patent License, (Exclusive)
Feasibility Study, Subsidized	Personnel Loan
Fellowship/Scholarship	Price Support
Grant	Regulation
Initial Product Purchase, Buy In	Reinsurance Support
Jointly-Funded Project	Standards, Federal
Lease, Minerals	Tax Credit
Lease, Public Sites	Testing of Products, Federal
Liability Limits	

T² ORGANIZATIONAL INCENTIVES

Awards	Promotion
Bonuses	Recognition
Directives	Reorganization
Mandates	Reporting Standards
Personnel Loan to Industry	Team Building Efforts
Personnel Loan from Industry	Travel
PPBS Requirements	Royalties

OTHER

Data Swaps
Government Interagency Agreements
International Agreements
International Conferences
Technical Exchanges
Personnel Exchanges

8.0 INFORMATION RESOURCES

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

GUIDE TO SECTION 8.0

Section 8.1 defines information and its 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 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 accessed and applied. The efficient use of information requires more than just collection of data and its dissemination.

Since the Industrial Revolution, manufacturing has been the backbone of the economic process. During the 1970s and 1980s there has been a shift from a manufacturing-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. Information generated worldwide is collected and stored in a computer database, 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, the amount of information available in electronic form is contained in over 4,000 databases, 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?

- A. 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 digital format and store it within a computer.

The generation and storage of information follows a sequential process. Information is generated by a researcher who generates a report. This report is then published in the traditional print media (e.g., book, journal, or special document). The resulting 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 description of content (citation). This abstract is then stored in an electronic database. Most databases only contain abstracts or citations rather than the complete text. The retriever can rapidly retrieve and 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 advances by the users of the information. Thus, the abstractor's job is a critical one. To facilitate the process and to enhance retrieval, a sequence of "key words" (for example 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 technical 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, in finding all citations written by a certain author on a specific topic, use by the researcher of the logical operator AND will reduce the number of citations that will have to be reviewed.

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 databases.

Universal standards for abstracting and storage are developing and, standardization is gradually occurring. This 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

SAMPLE CITATION

86N30882# ISSUE 22 PAGE 3444 CATEGORY 27 RPT#:
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UNCLASSIFIED DOCUMENT

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

AUTH: A/HSU, S. M.; B/HUBBARD, C. R.

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

SAP: Avail: NTIS HC A05/MF A01

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?

- A. 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 (MEDLARS). 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 database 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. A configuration of 640K RAM (memory) with a 20 MB hard disc is sufficient to carry out the retrieval process in an efficient manner. 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 dot matrix printer is sufficient.

Access to a database 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, most database services 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 databases 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 databases 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 for review, or is electronically "downloaded" from the database computer to the local workstation. The electronically recovered results are then reviewed on the workstation by the individual interested in the information.

INFORMATION ACCESS

SEARCHING

8.4 How Does Information Impact the Technology Transfer Process?

- A. 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 incorporation of incremental know-how.

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 carry out the brokerage function successfully 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.

INFORMATION MANAGEMENT

8.5 Resource Networks

- A. The aggregation and transmission of information has generated major industries. In the 1960s, only one or two databases existed. In the 70s, with the advent of faster, inexpensive computers, more databases were developed, in particular, by the private sector. By the 1980s, over 4,000 specialized databases were in existence. In the 1990s, merging of database vendors is occurring.

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 databases may be directly accessed through the agency network, or through commercial services such as Dialog, BRS, STN, Maxwell, 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.

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 databases 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 access points have been formed, e.g., the NASA Regional Technology Transfer Centers, the National Technology Transfer Center (NTTC), the DOD Information Analysis Centers, and NTIS, universal linkage does not yet exist. The NTTC is attempting to develop such a linkage as part of its overall national transfer mission. Until then, 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.

Professional development occurs through participation in national symposia and through organized societies. Organizations such as the Federal Laboratory Consortium (FLC), the Association of Federal Technology Transfer Executives (AFTTE), the Technology Transfer Society, and the Licensing Executives Societies are a few examples of the organizational resources available for professional development. Training is also available from the private sector, and from the Office of Personnel Management (OPM course on Technology Transfer), the FLC and the AFTTE. Again, no universal curriculum exists, although it is under development at the NTTC. Most agents are self-taught.

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

9.0 FEDERAL TECHNOLOGY TRANSFER POLICY

1. What is the National policy on technology transfer?
 2. What are the key T²-related legislative laws and Executive Orders?
 3. Is there a lead Federal organization for technology transfer?
 4. Are there Department of Energy-specific guidelines or directives on technology transfer?
 5. What are CRADAs?
 6. What incentives are there for a Federal technology developer or the T² manager to champion technology transfer?
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GUIDE TO SECTION 9.0

Sections 9.1 through 9.3 provide an overview of the legislative and Federal government policy framework for technology transfer.

Sections 9.4 and 9.5 summarize Department of Energy-specific guidelines and directives for Departmental T² programs. In particular, the Cooperative Research and Development Agreement (CRADA) tool for working with the private sector is described.

Section 9.6 discusses some of the incentives for Federal technology developers and T² managers to transfer Federally developed technologies to the commercial marketplace.

9.1 What is the National policy on technology transfer?

- A. It is the National policy of the United States government to strive to transfer Federally developed or owned technologies to the commercial marketplace in an effective manner. The only exceptions to the universal application of this policy are for those technologies that are determined to be of national security interests.

This "National policy" is comprised of a number of key technology transfer laws; stated policies on such related nationally affected issues as international industrial competitiveness, national security, and international trade; and the rationale for the nature and R&D missions of Federal agencies.

The "National policy" on technology transfer recognizes that technology development and innovation are central to the economic growth, national security, and social well-being of the citizens of the United States. Further, it is the stated National policy to promote actively the transfer of Federally developed or owned technologies to the commercial marketplace.

A number of key Acts, such as the those listed in Section 9.2, directly articulate and codify this policy and provide guidance for the promulgation of regulations to implement this policy. In addition, legislation dealing with such diverse topics as health care, taxation, international trade, transportation, the environment, and defense also contain direct and indirect policy guidance on technology transfer. Executive Orders by the President of the United States direct Federal agencies to undertake specific technology transfer-related activities.

The National policy on Federal technology transfer is also clearly and implicitly reflected in the nature and mission of R&D programs supported by Federal agencies. Indeed, the entire rationale for government-sponsored non-military R&D is based on the premise of eventual commercial application of resulting technology and information. Be it basic knowledge and understanding of natural phenomena, broad-based generic technology, or formulations, equipment and process for specific applications, the underlying thrust of Federal R&D is transfer to industry for commercial use. Increasingly, results of military R&D are being reviewed for expanded technology transfer efforts.

9.2 What are the key T²-related laws and Executive Orders?

- A. While the first major technology transfer-related law dates back to the Morrill Act of 1862 (which created the Department of Agriculture and established the system of Land Grant Colleges) the major laws that shape current Federal activities in technology transfer were passed in the 60s, 70s, and particularly, the 80s.

There are eleven major laws pertaining to Federal technology transfer - eight of them were passed in the last thirteen years. These laws are:

- * Atomic Energy Act of 1954 (PL 83-703)
- * Freedom of Information Act of 1966 (PL 89-554)
- * Federal Nonnuclear Energy Research and Development Act of 1974 (PL 93-557)
- * Stevenson-Wydler Technology Innovation Act of 1980 (PL 96-480)
- * Patent and Trademark Amendments Act of 1980 (PL 96-517) also known as Bayh-Dole
- * Federal Technology Transfer Act of 1986 (PL 99-502)
- * Omnibus Trade and Competitiveness Act of 1988 (PL 100-418)
- * National Competitiveness Technology Transfer Act of 1989 (PL 101-189)
- * National Defense Act for FY 1993 (PL 102-484)
- * Energy Policy Act of 1992 (PL 102-486)
- * Small Business Technology Transfer Act of 1992 (PL 102-564)

The Morrill Act of 1862 was the first major law dealing substantively and explicitly with Federal technology transfer. In creating the Department of Agriculture and establishing the highly successful system of U.S. Land Grant Colleges, the Act charged the new Department "to acquire and diffuse...useful information on subjects connected with agriculture...and to conduct practical and scientific experiments". In 1914, the Smith Lever Act mandated the Department of Agriculture to establish the Agricultural Extension Service, which even today serves as a model for technology transfer outreach to a defined audience.

The eleven major laws explicitly dealing with Federal technology transfer to the commercial marketplace are summarized below:

Atomic Energy Act of 1954 (PL 83-703):

- Provided for agency to take title to agency-developed inventions
- Provided for dissemination of technical information and provided protection of classified data
- Allowed the Atomic Energy Commission to license its patents to private industry
- Permitted contractors to take ownership of non-nuclear inventions

Freedom of Information Act of 1966 (PL 89-554)

- Provided a mechanism for fully informing public about government activities

Federal Nonnuclear Energy Research and Development Act of 1974 (PL 93-577)

- Provided for wide public dissemination of government-owned energy information in the shortest practical time
- Promoted commercialization of government developed technologies and information by the private sector
- Created single patent policy for agency, with broad waiver authority

Stevenson-Wydler Technology Innovation Act of 1980 (PL 96-480)

- Explicitly stated that it was the national policy to strive to transfer Federally-developed or owned technology to the private sector
- Established the Offices of Research and Technology Application (ORTA) at major Federal R&D laboratories to promote T² activities
- Established the Center for the Utilization of Federal Technology (CUFT) within the National Technical Information Service of the Department of Commerce

Patent and Trademark Amendments Act of 1980 (PL 96-517) -[Bayh-Dole]

- Provided certain rights for non-profit organizations (including universities) and small businesses in dealing with patents developed under government contracts
- Protected information on inventions for a limited time from requirements under the Freedom of Information Act

Federal Technology Transfer Act of 1986 (PL 99-502) - [FTTA]

- Amended Stevenson-Wydler Act
- Provided for preference to U.S.-based businesses in transferring Federally-developed or owned technologies
- Explicitly stated that T² is the responsibility of every Federal laboratory and every employee (made T² a criterion in evaluating an affected employee's performance)
- Authorized Cooperative Research and Development Agreements (CRADA) for government-owned/government-operated (GOGO) facilities
- Provided for exchange of GOGO laboratory personnel, services, and equipment with private sector partners
- Established the charter for Federal Laboratory Consortium (FLC)
- Provided specific incentives to GOGO researcher for inventions and T² accomplishments

Omnibus Trade Competitiveness Act of 1988 (PL 100-418)

- Established regional university-based Manufacturing Technology Centers
- Established Industrial Extension Service within states and an information clearinghouse on state and local programs operated by the Department of Commerce
- Established Training Technology Transfer Centers under Department of Education
- Broadened T² role of the National Institute of Standards and Technology (NIST) under the Department of Commerce

National Competitiveness Technology Transfer Act of 1989 (PL 101-189) - [NCTTA]

- Authorized Cooperative Research and Development Agreements (CRADA) for government-owned/contractor-operated (GOCO) facilities
- Established T² as a mission for every GOGO laboratory

National Defense Act for FY 1993 (PL 102-484)

- Requested "consideration" for spending not less than 10% of R&D budget for T² activities
- Directed DOE to establish program for T² to small businesses

KEY T² - RELATED LEGISLATION AND DOE DIRECTIVES

1992	PL 102-564	Small Business Technology Transfer (STTR) program
1992	PL 102-486	Energy Policy Act (EPACT)
1992	PL 102-484	National Defense Act for FY 1993
1992	SEN 30A-92	Staying the Course for Technology Transfer at the Department of Energy
1991	SEN 33-91	Departmental Management of Science and Technology
1991	SEN 30-91	Setting the Course for Technology Transfer at the Department of Energy
1989	PL 101-189	National Competitiveness Technology Transfer Act (NCTTA)
1988	PL 100-418	Omnibus Trade and Competitiveness Act
1986	PL 99-502	Federal Technology Transfer Act
1980	PL 96-517	Patent and Trademark Amendments Act (also known as Bayh-Dole)
1980	PL 96-480	Stevenson-Wydler Technology Act
1974	PL 93-577	Federal Nonnuclear Energy Research and Development Act
1966	PL 89-554	Freedom of Information Act
1954	PL 83-703	Atomic Energy Act

Energy Policy Act of 1992 (PL 102-486)*

- Provides DOE with authority to enter into CRADAs directly with industry, without Federal laboratory participation
- Provides authority to protect a wider range of information
- Provides limited protection to DOE/industry joint ventures from antitrust suits

* (Interpretation of provisions under review as of publication date)

Small Business Technology Transfer Act of 1992 (PL 102-564)

- Establishes 3-year pilot Small Business Technology Transfer (STTR) program under the Small Business Administration at five Federal agencies including DOE

In addition to these eleven laws, a number of others (such as the Trademark Clarification Act of 1984, the Cooperative Research Act of 1984, and the American Preeminence Act of 1991) contribute to defining and regulating the transfer of Federally developed or owned technology to the commercial marketplace. Executive Orders 12591 and 12618, signed in 1987, further emphasized the Federal commitment to technology transfer.

9.3 Is there a lead Federal organization for technology transfer?

- A. There is no one single Federal organization that is responsible for across the board technology transfer. While certain agencies are specified in some of the T²-related legislation, all agencies that support R&D are implicitly charged with undertaking T² activities. The major R&D-oriented Departments and independent agencies include:

- * Department of Agriculture
- * Department of Commerce
- * Department of Defense
- * Department of Energy
- * Department of Health and Human Services
- * Department of Interior
- * Department of Transportation
- * Department of Veterans Affairs
- * Environmental Protection Agency
- * National Aeronautics and Space Administration

While each affected Federal organization has some stated policy on technology transfer, the level of T²-related activities at these departments and agencies varies not only from one to the other, but also from one office or service within a department to another. Some departments and agencies have more formalized T²-related guidance originating at the secretarial or administrator level, while others delegate the authority to sub-organizational levels. The Departments of Defense and Energy, and the Environmental Protection Agency and the National Aeronautics and Space Administration perhaps have been the most aggressive in developing and implementing explicit T² activities.

9.4 Are there Department of Energy-specific guidelines or directives on technology transfer?

- A. In addition to the general body of T²-related legislation (including specific references in legislative acts and Executive Orders to DOE and DOE laboratories), DOE policies and operational procedures are guided by 1) Secretary of Energy Notices, 2) recommendations of a Departmental cross-cutting Technology Transfer Committee, and 3) policies and guidelines resulting from the Technology Transfer Field Task Force.

Three specific Secretary of Energy Notices (SEN) address technology transfer at the Department of Energy:

SEN 30-91: Setting the Course for Technology Transfer at the Department of Energy set the vision and policy framework for establishing an enhanced technology transfer program at DOE. It articulated a statement of purpose, mission, and goals in T²; described management philosophies and operational strategies; and defined organizational roles and responsibilities.

SEN 33-91: Departmental Management of Science and Technology established the function of a Science and Technology Advisor (STA) to the Secretary of Energy and defined the responsibilities and relationships of the STA with respect to other T² functions within DOE.

SEN 30A-92: Staying the Course For Technology Transfer at the Department of Energy updated SEN 30-91, reaffirming DOE commitment to technology transfer and to the National Technology Initiative.

The DOE Technology Transfer Committee (TTC) was established in December 1992 as a mechanism for Department-wide coordination and recommendations on T² issues. The TTC is chaired by the Director of the Office of Technology Utilization within the Office of the Science and Technology Advisor. All DOE program areas are represented at the Deputy Assistant Secretary level.

After the signing of the National Competitiveness Technology Transfer Act of 1989, DOE undertook a major effort to review its technology transfer mandates, objectives, and activities to develop Department-wide policies and guidance on technology transfer. This effort was carried out by the Technology Transfer Field Task Force (TTFTF), comprised of representatives from headquarters, field offices, and national laboratories involved with all DOE technology program areas including Defense Programs. The discrete set of policy recommendations and guidance resulting from this activity has become the basis of a more formalized, aggressive Department-wide T² effort.

9.5 What are CRADAs?

- A. CRADA is an acronym for Cooperative Research and Development Agreement, as authorized by Section 11 of the Technology Transfer Act of 1986.

A Cooperative Research and Development Agreement is a mechanism for one or more Federal laboratories or agencies to enter into a type of joint venture to develop, refine and commercialize a technology. The Federal laboratory or agency commits to provide facilities, equipment, personnel, or other resources to conduct specified R&D in conjunction with a non-government organization. No Federal funds go to the private sector CRADA partner, but reimbursements for government costs may be negotiated as part of the agreement. Rights to inventions, patents, copyrights, or other intellectual properties are negotiated within the CRADA. Limited protection (up to 5 years) of certain information and data generated by the joint R&D may also be negotiated as part of the agreement.

9.6 What Incentives are there for a Federal technology developer or the T² manager to champion technology transfer?

- A. In addition to intangible rewards (such as increased prestige and/or responsibility, opportunity to participate in the development of new and exciting technologies, a sense of achievement, etc.) for T² accomplishments, there are a number of tangible incentives provided by statute.

The Technology Transfer Act of 1986, in concert with the Stevenson-Wydler Innovation Act which it amends, explicitly provides for the following incentives to the Federal researcher:

- * Encourages consideration of employees T² accomplishments in evaluating performance
- * Requires agencies doing a significant amount of R&D to set up a system of cash awards for inventions, innovations, or other outstanding T² contributions (This is in addition to any royalty-sharing incentives.)
- * Requires a minimum of 15% of income from technology licensing royalties to be paid to the Federal employee responsible for the licensed invention (Most agencies have increased this to 20% or 25%. This applies to researchers who contributed to the invention or innovation but were not named in a patent.)
- * Authorizes Federal agencies to transfer ownership right in an invention to the responsible employee if the agency does not intend to file for a patent or otherwise move the invention to the private sector.
- * Provides that more than 50% of the income from royalties go to the inventing laboratory

In addition, each agency may have explicit and implicit incentives for T² in terms of:

- * Returning a portion of the royalty income to the T² program (as is currently being done at NASA)
 - * Travel funds for consulting with industry
 - * Sabbaticals to pursue technology commercialization in the private sector
 - * Early retirement to pursue an innovation
 - * Permission to consult privately
 - * Funding for internal independent research and development
-

10. LEGAL CONSIDERATIONS IN TECHNOLOGY TRANSFER

1. What are the primary legal considerations regarding technology transfer?
 2. How do intellectual property laws affect technology transfer?
 3. What should the T² manager know about patent and trade secret law?
 4. What should the T² manager know about copyright law?
 5. What should the T² manager know about trademark law?
 6. What should the T² manager know about antitrust law?
 7. What should the T² manager know about international and foreign national laws?
 8. What references can the T² manager refer to for additional information?
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GUIDE to Section 10.0

Section 10.1 discusses briefly key legal considerations which can impact favorably or adversely the technology transfer process.

Section 10.2 defines the nature and content of intellectual property laws and their effect on technology transfer.

Sections 10.3 through 10.5 give a brief summary of U.S. patent, trade secret, copyright, and trademark laws.

Section 10.6 cautions the technology manager to be aware of potential conflicts with U.S. antitrust laws.

Section 10.7 discusses briefly the need to consider the possible impact of international law and foreign national laws on the technology transfer process.

Section 10.8 presents a brief bibliography for the T² manager desiring additional information.

10.1

What are the primary legal considerations regarding technology transfer?

- A. The concept of the Technology Delivery System was covered in Section 4. The benefit of the TDS model is that it clearly delineates the players, their roles, and their interactions. The message that comes through loud and clear from the model is that the technology transfer process is complex and for the successful transfer of technology to take place **ALL ACTORS AND ALL LINKAGES MUST BE ACTIVATED**. Many technology transfer programs are minimally effective (sometimes abysmal failures) simply because one or several of the key linkages had not been activated --- for example, no source of venture capital was made available, or the inability in the short term to change regulatory restrictions (such as building codes prohibiting the introduction of new materials) was not seriously addressed.

One of the key actors often forgotten by the technology transfer manager in the development of his/her TDS model is the lawyer and his/her important role in the technology transfer process. The legal role and its complexities cannot be covered comprehensively in this Guidebook. The important point is that the technology transfer manager must be sensitive to the legal ramifications, and be prepared to draw upon the professional knowledge of legal counsel. Legal counsel, for example, will be indispensable in negotiations and drawing up contracts, in providing guidance on tort law (product liability and safety are a major concern to manufacturers of any technical process or product), in environmental law, in SEC matters, in OSHA law, in antitrust law, and in negotiating and implementing international programs.

While not down-playing the significance of these general law considerations, of greater importance by far to the technology transfer manager are the provisions of U.S. intellectual property law, highlighted below.

THE TECHNOLOGY DELIVERY SYSTEM'S LEGAL SUBSYSTEM

1. The Financial Subsystem

- Tax Laws
- Security Laws
- Insurance Laws
- Franchising Laws
- Surety Laws
- Mortgage Finance Laws

2. The R&D Subsystem

- Contract Law
- Intellectual Property Law
 - Patents
 - Trade Secrets
 - Copyrights
 - Trademarks

3. The Economic Subsystem

- Antitrust Laws
- Fair Trade Laws
- Commercial Transaction Laws
- Unfair Competition Laws
- Corporate/Partnership Laws

4. The Customer

- Consumer Protection Laws
- Warranty Laws
- Fair Trade Laws
- Contract Laws
- Tort Laws

5. The Regulatory Subsystem

- Environmental Laws
- Public Health Laws
- Safety Laws
- Zoning Laws

- A. Perfecting an invention and carrying it to the marketplace can be a very expensive process. Generally, the inventor (unless he is independently wealthy) must depend upon outside sources of financing. Potential investors will need to be assured that their investment will be protected, else they will invest in less risky ventures. There is nothing more discouraging than to pay expensive front-end costs (R&D, development, engineering, prototyping, market research, and marketing) of a new product, and have it copied as soon as it becomes commercially successful. The copier, because he does not need to recoup any front end costs, can charge a lower price, taking over the entire market. To preclude such a financial disaster, investors will require some form of legal protection, generally falling under the rubric of intellectual property law.

Intellectual property law codifies rights in intangible products of the mind apart from their physical embodiment. In general, a property right provides the possessor of the property the power to exclude; intellectual property rights give the possessor the right to exclude others from physical embodiments of one's original ideas. Because of historical development, traditions, and legal doctrines, intellectual property law has evolved as a number of special fields including: patents, trade secrets, trademarks, and copyrights.

Patents: protect under Federal law the innovative principles of new products, processes, machines, and compositions of matter.

Copyrights: protect under Federal law the expression embodied in recorded information, including written works, music, audiovisual works, computer programs, and other works of authorship.

Trademarks: protect under Federal and state laws innovative symbols used by merchants to identify their goods.

Trade Secrets: are protected under variations of a "uniform trade secret protection act" in some twenty-odd states, and under common law in the rest of the states.

Miscellaneous:

- * The Semiconductor Chip Protection Act of 1984 protects the physical designs of integrated circuits.
- * The Plant Variety Protection Act of 1970 protects under Federal law sexually reproduced new plant varieties.
- * State statutes and common law protect property rights such as rights of publicity, and protection against unfair competition.

10.3

What should the T² manager know about patent and trade secret law?

- A. Patent law is the most important form of intellectual property law for the T² manager. Patent law provides protection to the inventor and his investors for 17 years from the date of issuance of the patent, enabling the patentee to exploit commercially his invention free of infringing competitors.

There are three types of patents under U.S. law, viz., utility patents, design patents, and plant patents. Utility patents cover inventions; design patents provide for protection of certain designs for articles of manufacture; whereas plant patents protect the inventor of a new variety of asexually [i.e., without seeds] reproducing plant. [If the new plant is sexually reproduced, protection is available under the Plant Variety Protection Act of 1970.] We will focus exclusively on utility patents, since they are of most importance to the T² manager.

A patent for an invention is a grant of certain property rights by the Government (through the Patent and Trademark Office) to an inventor. The duration of the patent grant is 17 years from the date of issuance. The property right conferred by the patent grant extends throughout the United States, its territories, and possessions. The right conferred by the patent grant is "the right to exclude others from making, using, or selling" the invention. Note carefully that the grant is not "the right to make, use, or sell," but the right to exclude others from making, using, or selling the invention. A moment's thought will make clear this distinction. Most inventions are modifications or improvements over the current state of the art. Let's assume we have just invented and patented a device wherein we add an eraser to a lead pencil (which we will assume was patented just five years ago). Neither we nor the owner of the pencil patent can legally manufacture a pencil with an eraser--both of us can use our exclusionary rights to prevent the other party from infringing our patent. Generally, in such cases one party will license or sell his patent rights to the other party. Or if we wait 12 more years until the pencil patent enters the public domain, we can then manufacture pencils with erasers and exclude anyone else from so doing until our patent grant runs out.

Patent law is largely statutory law (see United States Code, Title 35--Patents). The most important sections of the code for the T² manager are sections 101, 102, 103, and 112. Let us now briefly examine these four sections.

Section 101. Inventions patentable

Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

Comment: Three points should be noted. First, the inventor must be able to characterize his invention as a process, machine, manufacture, or composition of matter. Generally this is not difficult; in fact, often an invention will fall into more than one category-- in which case it is immaterial as to the category chosen to characterize the invention. Secondly, note that the invention must be new (a synonym for novel) and useful. (For

example, some new chemicals were rejected during the patent application process because no specific use could be shown for them.) Finally, note that the inventor has a right to a patent--it is not a matter of governmental discretion -- if he satisfies the conditions and requirements set forth in the statute.

It should be noted that there are a few judicial exceptions to patentability; the following items cannot be patented:

- * laws of nature
- * natural forces
- * basic principles
- * mere chemical formulas
- * business methods
- * systems of bookkeeping
- * methods of calculation
- * mental steps
- * ideas

As mentioned above, to be patentable an invention must be new (novel) as defined in Section 102.

Section 102. Conditions for patentability; novelty and loss of right to patent.

A person shall be entitled to a patent unless --

- (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or
- (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of the application for patent in the United States, or

....

- (g) before the applicant's invention thereof the invention was made in this country by another who had not abandoned, suppressed, or concealed it.

Comment: This section describes the standards for novelty, and creates a statutory bar if the patent applicant is not careful.

Novelty - If the invention has been described in a printed publication anywhere in the world, or if it has been in public use or on sale in this country before the date that the applicant made his invention, a patent cannot be obtained. These novelty requirements are strictly interpreted, e.g., even though the printed publication is a student thesis filed in an obscure university in a distant land many years ago, if therein is contained a sufficient description of the invention the publication can be used to prevent obtaining a patent (or be used to subsequently invalidate the patent if the thesis is found later, generally during infringement proceedings).

HAZARDS AND TRAPS FOR THE APPLICANT

Statutory Bar -If the invention has been described in a printed publication anywhere, or has been in public use or on sale in this country more than one year before the date on which an application for patent is filed in this country, a valid patent cannot be obtained. In this connection it is immaterial when the invention was made, or whether the printed publication or public use was by the inventor or someone else. Note well: If the inventor describes the invention in a printed publication (for example, in an article in a scientific journal), or uses the invention publicly (for example, during marketing tests or surveys), or places it on sale (or even offers to sell), the inventor must apply for a patent before one year has gone by, otherwise he will lose all rights to a patent.

Closely, related to the concept of novelty is an additional requirement of "non-obviousness", which was developed by the courts in the 19th century and subsequently added to the patent statute in 1952 as Section 103.

Section 103. Conditions for patentability; non-obvious subject matter

A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

In 1850, the Supreme Court in Hotchkiss v. Greenwood held that the mere substitution of a porcelain door knob handle for the wooden door knob handle of the prior art did not constitute a patentable invention. The Court drew a distinction between true invention and mere mechanical skill, indicating that only those contributions evidencing invention would be worthy of patent protection. From then on, a new and useful contribution to be patentable must also exhibit unobviousness--a quality, unfortunately, which often lies in the eyes of the beholder (or the court reviewing patent validity).

Finally, let us look briefly at the key provisions of Section 112.

Section 112. Specification

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art... to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Comment: Section 112 is probably the most important procedural provision in the statute, setting forth what the applicant must include in the description of his invention. In brief, he must include:

- (1) a clear description of the invention,
- (2) a clear description of how to make the invention,

- (3) a clear description of how to use the invention, and
- (4) a clear description of "the best mode contemplated by the inventor of carrying out his invention."

Failure to satisfy any of these requirements will lead to rejection of the inventor's patent application, or if a patent somehow issues, can serve as the basis for a patent invalidity holding in a subsequent infringement suit. By "best mode" is simply meant the inventor's preferred method at the time of patent application of making and using his invention. As an example, let us assume an important part of his invention is a plastic component--but only one type of plastic material will satisfy all the requirements to make the invention operate satisfactorily. If the inventor intentionally remains silent and fails to indicate this critical fact in his patent application, and if this fact is discovered in a subsequent infringement suit, his patent will likely be held invalid for failure to satisfy Section 112's "best mode" requirement.

The applicant must always keep in mind that he is seeking a grant from the government that in essence provides him with a 17-year monopoly. In turn, he is obligated to provide the public with an adequate description of his invention so that anyone can make or use his invention after the term of his patent grant lapses. A patent is to teach the reader about the invention. Anything less than complete candor and honesty in prosecuting his patent application violates the applicant's obligations, which can lead to serious sanctions.

An application for a patent is made to the Commissioner of Patents and Trademarks and must include:

- (1) a specification as prescribed by section 112,
- (2) a drawing (where a drawing is possible), and
- (3) an oath that the inventor believes himself to be the original inventor of the product or process for which he solicits a patent.

Once again it should be emphasized that the specification lies at the heart of the application, and the claims therein will define the boundaries of the patentee's property rights after the patent issues. Drafting valid patent claims is extremely important, extremely difficult, and not a job for novices. A patent claim must neither be too narrow (in which case the applicant fails to claim all he is entitled to), nor too broad (in which case the claim may read upon the prior art and not be patentable for lack of novelty). A prudent T² manager will seek the advice of patent counsel in pursuing patent applications.

Trade secret protection is sometimes a viable alternative to patent protection. Trade secrets, as defined by the Uniform Trade Secrets Act, encompass "information, including a formula, pattern, compilation, program, device, method, technique or process that: (i) derives independent economic value, actual or potential, from not being generally known to, and not being readily ascertainable by proper means by, other persons who can obtain economic value from its disclosure or use, and (ii) is the subject of efforts that are reasonable under the circumstances to maintain its secrecy."

The subject of a trade secret need not be inventive in the patent law sense, but some novelty will be required since that which does not possess novelty is usually known. Secrecy lies at the heart of trade secret law. This limits the subject matter which can be protected. For example, machines and articles of manufacture (as well as many compositions of matter) can be "reverse engineered," which is perfectly legal. By reverse engineering is meant taking apart the item of interest and learning how to

manufacture it. Obviously trade secrecy is of no value in such cases, whereas patent law, if the item meets all the patentability requirements, would offer legal protection. In a sense this limits trade secrecy to manufacturing and chemical processes which can be kept secret within the confines of the manufacturing plant. Other types of material entitled to trade secret protection are formulas (such as for the preparation of food, drugs, diets, and cosmetics), methods and techniques, customer lists, sources of supply, advertising and marketing plans, and financial data.

Under state law, a firm's trade secrets will be protected against misappropriation by others. This includes disclosure or personal use by current or former employees, or through illegal activities of strangers (such as taking aerial photographs of a new chemical plant while under construction to learn details of the manufacturing process). Remedies in such cases may include compensatory and punitive damages, and in suitable cases, an injunction against use or further disclosure of the trade secret. It should be noted, however, that a successful lawsuit may represent a hollow victory for the trade secret owner. If before or during trial the nature of the trade secret is broadly disseminated, it may be impossible to put the plaintiff back into the position held before the violation--especially if he is dealing with an essentially judgment proof former employee. Here patent protection, if available, would obviously be the preferred form of protection.

There is no general Federal criminal law against trade secret theft. However, some courts have held the taking of unauthorized copies of trade secret documents across state lines clearly violates the National Stolen Property Act. Many states have laws making trade secret theft a crime.

COMPARISON OF PATENT AND TRADE SECRET PROTECTION

	<u>U.S. Patent</u>	<u>Trade Secret</u>
Legal Requirement:	New, useful, and not obvious	Not general knowledge in the trade; reasonable steps must be taken to protect secrecy.
Subject Matter	"Any new and useful process, machine, manufacture, or composition of matter." [35 U.S.C. Sec. 101.]	"Any formula, pattern, device or compilation of information which is used in one's business, and which gives.. an advantage over competitors." [Restatement, Torts, 1938]
Scope of Protection:	Can exclude all others from making, using, or selling the invention in the United States. [35 U.S.C. Sec. 154.]	Protection only against those who learn of the trade secret from the owner, or who improperly obtain it. No protection from those who develop the same information independently or by reverse engineering.
Duration of Protection:	Seventeen years from the date of the patent grant.	Indefinitely; until the secret becomes generally known in the trade.
Remedies:	Damages, not less than a reasonable royalty; can be trebled. Injunction possible. Attorney fees possible. Proceedings in federal courts only.	Damages, profits and injunction possible. Attorney fees possible. Proceedings based on state law.

10.4 What should the T² manager know about copyright law?

- A. Copyright protection can be important to the T² manager in protecting important intellectual property rights, e.g., protection of computer programs -- both source and object codes.

Basically a copyright protects the "writings" of an "author" against copying. The Copyright Act of 1976 protects an author as soon as his work is recorded in some concrete way, i.e., in writing, printing, recording, filming, etc. The copyright protection lasts for the lifetime of the author plus an additional fifty years. The copyright owner has exclusive rights to make copies of the work, and anyone producing unauthorized copies is subject to an infringement suit, as well as criminal prosecution under the Federal copyright laws.

Over the years, the words "writings" and "authors" have taken on expansive meanings under the copyright laws. Section 102 of the Copyright Act lists seven categories (which are not all-inclusive) of protected subject matter: (1) literary works, (2) musical works, (3) dramatic works, (4) choreographic works, (5) graphic works, (6) audiovisual works, and (7) sound recordings. Formerly, computer codes were copyrighted as literary works, and the audio and visual screen outputs as audiovisual works. Today the Copyright Office's position is that a single registration of a computer program protects both the literal elements of the program and the screen display generated by the program.

It should be clearly understood that copyrights protect only the expression of an idea, and not the idea itself -- which becomes the common property of all mankind. Copyright does not prevent anyone from copying the ideas or facts contained in a copyrighted work. The basic concept of copyright is originality (comparable to the concept of novelty in patent law). However, an author need not demonstrate novelty, only that the work originated with him. Thus the two key concepts of copyright law are expression and originality.

Copyright protection, as contrasted to patent and trademark protection is essentially self-executing. An author's work is protected automatically by Federal copyright when the work is fixed in a tangible medium (e.g., written, printed, recorded, sculpted, etc.). There is no need to register the work with any agency. However, there are advantages in registering the copyright with the U.S. Copyright Office and depositing two ("best editions") copies for the use or disposition of the Library of Congress. For example, an author cannot sue for copyright infringement until he has registered the copyright.

Formerly, placing a copyright notice in a published work was essential. Since the U.S. accession in 1989 to the Berne Convention notice of copyright has little legal significance. Nevertheless, it does serve several purposes:

- (1) It informs the public the work is copyrighted;
- (2) It identifies the copyright owner; and
- (3) It determines the date the work was published.

It is recommended that a notice containing the following information be affixed to any original work: (1) ©, or "Copyright", (2) date of first publication, and (3) the name of the copyright owner; e.g., [© 1992 Yukon Publishing Co.].

Remedies for copyright infringement include injunctive relief, damages and profits, impoundment and possible destruction of infringing copies, attorney's fees, court costs, and criminal penalties (generally up to \$10,000 or one year's imprisonment. However, for large-scale piracy of records and tapes, punishment can be as high as \$250,000 and five year's imprisonment.)

There are many significant facets of copyright protection -- such as fair use, derivative works, infringement, photocopying, collective works, compilations, and works for hire -- which are beyond the scope of this brief overview. The T² manager is advised to seek competent legal counsel when copyright questions arise. [Also see U.S. Code, Title 17 -- Copyrights.]

- A. Trademarks provide the T² manager with a means of identifying and protecting his products or services, distinguishing them from those of competitors. In essence, a trademark protects the quality of the trademark owner's product (or service); however, it does not protect the product from being copied -- such protection must be sought under patent or trade secret law.

Trademarks may be protected under state law and/or under the Federal Lanham Act. (See United States Code, Title 15, Chapter 22-Trademarks.) The decision as to the appropriate degree of protection to be sought will depend largely on whether the products (or services) will be placed in interstate commerce, or essentially confined to intrastate trade. Since today's T² manager will generally be looking for broad--national and international -- protection, we will focus on Federal trademark law.

In brief, the Lanham Act provides the owner of a Federally registered mark with protection against use by others of similar marks if any confusion might result. Historically, priority of use determined the ownership of a contested mark. Under common law, a trademark had to be in commercial use before it could be protected. Recent amendments to the Lanham Act (Section 1051(b)) now permit "a person who has a bona fide intention... to use a trademark in commerce" to register the trademark in the Patent and Trademark Office.

The basic scheme of the Lanham Act is the maintenance of a national registration system of trademarks, service marks, and collective and certification marks. (Trade names are not registerable.)

The term "trademark" is defined as any word, name, symbol, or device, or any combination thereof used to identify and distinguish the product of one person from products manufactured or sold by others, and to indicate the source of the product. A "service mark" is the same thing as a trademark except that it identifies and distinguishes services. "Collective marks" are marks used by the members of a cooperative, association, or other collective group to identify their goods or services. A "certification mark" is any word, name, symbol or device used by a person other than its owner "to certify regional or other origin, material, mode of manufacture, quality, accuracy, or other characteristics of such person's goods or services or that the work or labor on the goods or services was performed by members of a union or other organization."

The owner of a trademark [service, collective, or certification mark] may register the trademark by:

- (1) filing with the Patent and Trademark Office a written application, a drawing of the mark, and such number of specimens of the mark as required;
- (2) paying the prescribed fee; and
- (3) complying with rules and regulations prescribed by the Commissioner.

There are certain categories of trademarks which the Commissioner can refuse to register; viz.,

- (1) marks comprising immoral, deceptive, or scandalous matter;
- (2) marks consisting of or comprising the flag or coat of arms or other insignia of the United States, or of any State or municipality, or of any foreign Nation;
- (3) marks consisting of a name, portrait or signature identifying a particular living individual except with his written consent;
- (4) marks which so resemble a mark already registered, as to be likely to cause confusion or to deceive; or
- (5) marks which are merely descriptive, or deceptively misdescriptive.

Registration of the trademark provides several significant advantages to the owner. First, it permits the registrant to overcome any claims by later users. (Federal registration on the Principal Register legally provides constructive notice to subsequent users.) Second, registration provides the registrant with access to the Federal Courts. Third, registration provides incontestability, which allows the registrant to bring an infringement action against another and forecloses the defendant from raising all but a limited number of defenses (such as the registrant obtained his trademark fraudulently; the mark was abandoned by the registrant; or the registrant used the trademark to violate the antitrust laws of the United States).

Under common law, trademarks have an unlimited life, so long as they are not abandoned or misused. Under the Lanham Act, certificates of registration remain in force for ten years. Each registration may be renewed for periods of ten years upon payment of the prescribed fee.

A registrant should give the public notice that his mark is registered by displaying with the mark the words "Registered in U.S. Patent and Trademark Office," or the letter R enclosed within a circle. In any infringement suit by a registrant, who has failed to provide such notice, no profits or damages may be recovered unless the defendant had actual (as contrasted to constructive) notice of the registration.

The remedies for infringement provided by the Lanham Act include: (1) injunctive relief, (2) an accounting for profits, (3) damages (including the possibility of treble damages), (4) attorney's fees in "exceptional cases," and (5) costs.

The prudent T² manager will consult legal counsel when he encounters trademark questions. There are many important trademark topics not touched upon in this brief overview; e.g., secondary meaning, the supplemental register, state anti-dilution statutes, concurrent registration, the functional bar, the very important provisions of Section 43 (a) of the Lanham Act, gray market goods, and cancellation of registration. It should be emphasized that a trademark is an important asset, which must be continuously protected. In many cases words that were originally used as trademarks were taken over by the general public as the common name of the product and became generic with the result that the trademark owner lost his trademark rights in the word. Consider the common words: aspirin, escalator, thermos, and yo yo -- these words were once valid trademarks, but were allowed to become generic terms to the detriment of the trademark owner. Adequate legal provisions could have prevented these losses.

- A. Antitrust law is simple in concept but complex in specific details. The T² manager should be conversant with the broad provisions of antitrust law, since the penalties for violations can be quite severe—including treble damages.

To gain a basic understanding of antitrust law, look to its origins. In the latter half of the 19th century corporate consolidations, giant trusts, and monopolies increasingly dominated the American economy. The public became outraged over abusive practices of the railroads, and other major industries including sugar, oil, cotton and whiskey. These public concerns led to the passage of the Interstate Commerce Act of 1887, the Sherman Antitrust Act of 1890, the Clayton Act of 1914, and the Federal Trade Commission Act of 1914. The purpose of these acts is to promote economic competition (largely by prohibiting monopolies and monopolistic practices). Let us briefly look at the key provisions of these acts.

The Sherman Act has two main provisions:

Section 1: Every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce ... is hereby declared to be illegal.

Section 2: Every person who shall monopolize, or attempt to monopolize, or combine or conspire with any other person or persons, to monopolize any part of the trade or commerce ... shall be deemed guilty of a felony.

The Clayton Act of 1914 specifies four monopolistic acts as illegal; viz., (1) price discrimination, (2) tying and exclusive dealing contracts, (3) corporate mergers of competing companies, and (4) interlocking directorates. Finally, the Federal Trade Commission Act of 1914 states: "Unfair methods of competition in or affecting commerce, and unfair or deceptive acts or practices in or affecting commerce are hereby declared unlawful."

As the T² manager develops his strategic plan within the applicable Technology Delivery System, he must keep in mind such antitrust prohibitions as: not joining with competitors (through research, manufacturing, or distribution) in ventures that could monopolize the pertinent market; not charging different prices to different customers (without an economic justification); and not tying the sale of one product to the required purchase of another (such as requiring the purchaser of a patented copier to buy paper from the manufacturer).

The interface of patent law and antitrust law can be a trap for the unwary. Whereas antitrust law is designed to prohibit monopolies, patent law is designed to grant monopolies for new inventions (albeit for a limited time -- 17 years). In exchange for this "monopoly" the patentee must provide the public with a complete description of his invention such that others skilled in the art can manufacture it. Moreover, the patentee must be candid, frank, and forthright in dealing with the Patent Office in the prosecution of his patent application. If due to false, misleading, or incomplete information provided to the Patent Office the patent is subsequently held invalid or unenforceable, the patentee may be exposed to the full rigors of the antitrust laws including the penalty of treble damages and possible criminal penalties.

Patents may be exploited commercially by the inventor, sold, or licensed by him to others for their use. Licensing is favored from an economics point of view since this expands use of the invention, increases overall competition, and causes more rapid diffusion of the new technology. Specific provisions of patent licenses, however, can attract antitrust attention, and must be drafted carefully with antitrust laws in mind. Questions such as price limiting provisions, field-of-use limitations, and tie-in requirements must be handled with care. Because the patentee may lose the enforceability of his patent (permanently or temporarily) and be subject to antitrust penalties if a court finds patent misuse, he should seek the advice of legal counsel from the outset in his efforts to sell or license his patent.

- A. Some of the T² manager's greatest opportunities and most difficult challenges lie in the international marketplace. Unfortunately, many Americans are very risk-averse and tend to avoid at all cost the international arena. The Japanese on the other hand, focus their trade efforts to a large extent on the world market, and are rewarded handsomely for their efforts. In the business world, risks and rewards are generally commensurate.

There are many ways the T² manager can transfer technology internationally and reap the rewards of his efforts. For example, he can simply set up a sales force to market U.S. products overseas. Or he can franchise a chain of businesses in foreign countries, or license the manufacture of specific products. Or he can enter a joint venture with nationals of a foreign country, or even build manufacturing plants overseas to produce products for the local and the international market.

Associated with all new ventures are a large number of business and financial risks. Trading overseas can greatly compound these risks; however the potential rewards will often warrant accepting the added risk. To reduce such risks to manageable proportions, the T² manager should consult with experienced legal counsel, both domestic and foreign counsel (in each country where significant ventures are planned). Tax laws in all countries can be extremely complex -- bringing up such troublesome problems as transfer pricing, and multiple-taxing of the same revenue. Significant organizational problems arise: in many countries foreign firms cannot own more than 49% of a corporation and key positions in the corporation must often be filled exclusively with citizens of that country. Intellectual property rights vary greatly, and some countries offer very limited protection. One of the biggest legal problems encountered quite often is finding ways to guaranty the repatriation of profits and initial investments. It can be very disconcerting to see hard-earned profits, sitting in a foreign bank, "disappear" as high inflation rates take their toll. Finally, there is the ultimate threat that a change of government (peaceful or otherwise) may lead to expropriation of all foreign assets.

Expert legal counsel can help in planning and executing entry into the world market. Counsel can help in identifying potential legal problems, in quantifying risk, in recommending prudent courses of action, and in making sure that neither U.S., foreign, nor international laws are broken.

KEY ELEMENTS OF INTERNATIONAL LAW

- * Foreign Investment Law
 - * Licensing Laws
 - * International Tribunals
 - * Dispute Resolution Mechanisms
 - * Tariff Barriers
 - * Non-tariff Barriers
 - * Franchising and Trademark Registration
 - * Profit Repatriation
 - * Investment Repatriation
 - * Transfer Pricing
 - * Currency Exchange Controls
 - * Letters of Credit
 - * Bills of Lading
 - * Insuring the Risk
 - * Trading with Non-market Economies
 - * Choice of Law Clauses
 - * Choice of Forum Clauses
 - * Enforcement of Foreign Judgments
 - * Expropriation Law
 - * Sovereign Immunity
 - * The Act of State Doctrine
 - * Extraterritorial Jurisdiction
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What references can the T² manager refer to for additional information?

- A. A selection of legal texts which the reader can pursue for general information is presented below. Once again the T² practitioner is cautioned to seek adequate legal counsel when faced with a legal problem.
1. J. Dratler, Jr., Intellectual Property Law: Commercial, Creative, and Industrial Property, Law Journal Seminars-Press, NYC (1992).
 2. R.H. Folsom, M.W. Gordon, & J.A. Spanogle, International Business Transactions, West Publishing Co., St. Paul, Minn. (1986).
 3. R.B. Hildreth, Patent Law: A Practitioner's Guide, Practising Law Institute, NYC (1988).
 4. A.R. Miller, & M.H. Davis, Intellectual Property: Patents, Trademarks, and Copyright in a Nutshell, West Publishing Co., St. Paul, Minn. (1990).
 5. S.C. Oppenheim & G.E. Weston, Federal Antitrust Laws, West Publishing Co., St. Paul, Minn. (1968).
 6. D.P. Rosenberg, Patent Law Basics, Clark, Boardman, & Callaghan, NYC (1992).
 7. J.M. Samuels, Patent, Trademark, and Copyright Laws, The Bureau of National Affairs, Inc., Washington, D.C. (1989).
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1. What should the T^2 manager know about the production function?
 2. How does the production function fit into the TDS concept?
 3. What are the differences between the defense TDS model and the commercial TDS model?
 4. What are the differences between the "ladder process" and the "incremental innovation process?"
 5. What are the most important points for the T^2 manager to keep in mind?
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GUIDE to Section 11.0

Section 11.1 discusses the economists' production function and its importance to the T^2 manager.

Section 11.2 explains how the production function plays an integral role in defining components of the Technology Delivery System.

Section 11.3 presents the defense and the commercial TDS models and explains their importance to the T^2 manager.

Section 11.4 discusses two approaches to bring new products to the marketplace and the appropriate role for the T^2 manager.

Section 11.5 presents key points the T^2 manager must follow to be successful.

11.1

What should the T² manager know about the production function?

- A. Economists find utility in the concept of a production function. Mansfield has defined it thusly: "For any commodity, the production function is the relationship between the quantities of various inputs used per period of time and the maximum quantity of the commodity that can be produced per period of time The production function summarizes the characteristics of existing technology at a given point in time; it shows the technological constraints that the firm must reckon with." [See E. Mansfield, Microeconomics: Theory and Application.]

Perhaps a deeper understanding of this concept can be gained through Nicholson's characterization of the production function (f):

$$Q = f(L, K, M, \dots)$$

where Q represents output of the product, L represents labor input, K represents capital (machinery) input, and M represents raw materials. The ellipsis in the equation indicates that many other factors -- such as entrepreneurial and innovative effort -- also enter into the production relationship. [See W. Nicholson, Microeconomic Theory: Basic Principles and Extensions.]

The economist's primary interest is to assist management in optimizing production within available resources (labor, capital, and raw materials) with existing technology. It is the T² manager's goal to go one step farther by introducing innovation into the production function, thus offering a better product, a higher production rate, and/or lower production costs.

The T² manager must always keep the concept of the production function in mind. The purpose of technology transfer is not the transfer of technology per se: the purpose is to help management improve its position in the marketplace through the transfer of technology embodied in a new commercially successful product or service.

- A. The purpose of the "technology delivery system" model is to clearly delineate all the players, their roles, and their interactions. Too often, T^2 managers focus exclusively on only one-step in the process, i.e., the step of transferring new technology from one research group to another (e.g., as with a CRADA). As long as the T^2 manager realizes this is only one step in the process -- and often not the most important -- no harm is done. However, the T^2 manager must understand that his job is not finished at this point, and the successful transfer of technology to the marketplace will only occur when all actors and all linkages in the appropriate TDS have been activated. The production function forces the T^2 manager to face up to the truism that unless a new product can be manufactured at a reasonable cost, in a timely manner, with satisfactory attributes (such as quality, and ease of operation and maintenance) it will not be readily accepted in the marketplace. Thus, an experienced T^2 manager must acquire a basic understanding of how products are designed, produced, and marketed if he is to be fully successful in his technology transfer efforts.
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11.3

What are the differences between the defense TDS model and the commercial TDS model ?

- A. Let us highlight the differences between the commercial TDS model and the defense TDS model (by defense we will include any Federal agency, such as DOD or NASA, which designs and develops a product for which the agency serves as the customer).

Generally, in the defense TDS model, production costs, although important, are less important than product attributes and timeliness. Technology transfer generally takes place rapidly in the defense model for a number of reasons, including: (1) the customer is interested in advanced technology, (2) the customer is interested in the rapid introduction of the new technology, (3) cost constraints are not as important as in commercial products, (4) greater risks can be taken by the customer, and (5) there are considerably fewer actors and linkages involved in the TDS.

On the other hand, the commercial TDS model has much more complexity, which inherently slows down the acceptance of new technology. To be commercially successful, a new product must perform better some function desired by consumers, and/or at a lower cost. Whereas in the defense model, the customer (i.e., the Federal agency) is involved in all facets of the process - from defining the need, participating in the research and even the manufacture, to the procurement of the final product -- in the commercial model, all risks and investments must be taken by the product developer (the manufacturer). His technology transfer efforts are only successful if the consumer prefers and buys his product in the marketplace. Most manufacturers are cautious in developing and introducing new products and tend to be risk-averse. This is one reason that most successful technology transfers will result from the efforts of a "product champion," i.e., someone who is convinced of the value of a new innovation and is willing to devote whatever time and effort are necessary to bring the product to the marketplace.

To a significant degree, the production function for similar products will be different in the two sectors. This difference must be clearly understood by the T^2 manager.

THE DEFENSE vs. COMMERCIAL TDS MODELS

DEFENSE TDS MODEL:

COMMERCIAL TDS MODEL:

11.4

What are the differences between the "ladder process" and the "incremental innovation process?"

- A. There is no doubt that the Japanese are the world's leaders in the art of technology transfer. Therefore it may come as a surprise to the T^2 manager to learn that over "the last several decades, Japan has never introduced the first product in any market on the basis of a significant new technical breakthrough. Transistors, integrated circuits, computers, fiber optics, lasers, computer tomography, magnetic resonance imaging, video recorders, and color television are among the many advances made in the West and first embodied in new products in the West. Yet in each of these areas the Japanese have subsequently gained a strong and sometimes dominant position." [See Gomory and Schmitt, "Science and Product," SCIENCE 27 May 1988, pp 1131-32, 1203-04.]

How the Japanese performed this apparent miracle is important for the T^2 manager to understand. In a sense, these technologies were initially (but temporarily) "transferred" in the West. But the true technology transfer leading to permanent commercial success took place in Japan. Why and how?

Let us begin by pointing out the obvious. The West and Japan have different production functions, with the Japanese production process clearly superior in the cases cited above. The U.S. performs well in what Gomory and Schmitt call the "ladder" process in which a new idea or technology dominates, and a product is created around it. Consider the development and commercialization of the transistor, which resulted from a buildup of fundamental knowledge about quantum mechanics and solid state physics. This is a science-to-product process in which U.S. industry and science, working together, clearly excel.

In contrast to this orderly process, is what Gomory and Schmitt call the "process of cyclic development" or the "process of repeated incremental innovation." It is in this process that Japan clearly excels. It is this process that, after the ladder-style invention of the transistor, has provided the world with better computer memories every year. This cyclic process leads to the continual improvement of an existing product. Although evolutionary in nature, significant changes in product attributes, quality, and price result from the cumulative effect of a series of incremental improvements.

Incremental development is built around an existing product (not around a new idea) and is essentially cyclical in nature. Let us assume we are involved in the early manufacture of VCR's. At the time we put the first model on the market, we would be involved in the design and development of a subsequent improved model. And when that model hit the market, we would already be involved in the next version. The length of the development and manufacturing cycle (the time between the introduction of two successive models) is most important from the T^2 manager's perspective. A firm with a shorter cycle will have newer products with newer technologies in the marketplace, and will gain a reputation for technical leadership. The Japanese have mastered this process and have managed to reduce greatly the length of the development-manufacturing cycle.

THE LADDER vs. THE CYCLIC PROCESS

THE LADDER PROCESS:

THE CYCLIC PROCESS:

As pointed out by Gomory and Schmitt:

"A key factor in the speed of the cycle, as well as in the quality and cost of the product, is the closeness of the tie between development and manufacturing. Design for easy manufacturability leads to rapid introduction into and buildup in the manufacturing stage. Close ties between development and manufacturing translate into early knowledge of technical problems, into speed of market introduction, and also into quality, because the product is easy to manufacture. A lack of close ties has the opposite effect."

- A. Most practitioners think of technology transfer as a linear phenomenon, whereas in the majority of cases it is a continuous, cyclical process. In order for the T^2 manager to be successful in helping to introduce a new product and maintain its position in the market he must assure that the firm's development/ manufacturing cycle is world class, otherwise "new" products will soon be buried under the dust of faster moving competitors.

From a broader perspective the T^2 manager must have a clear understanding and appreciation of the significance of the production functions for his firm and his industry. In broad terms the production function must encompass the appropriate mix and use of all resources required to bring a product successfully to the marketplace -- including all necessary design, test, manufacture, and marketing activities. A significant failure of a major technology transfer effort will make this point abundantly clear. In the late 1960s a Federal agency funded a defense electronics firm to develop an advanced lightweight, efficient two-way radio for use by municipal police forces. On the surface this appeared to be a simple "transfer" of aerospace technology to the civilian market. What the T^2 manager in this case failed to take into consideration was the production function and TDS of the firm involved in this project. Since the defense electronics firm was not involved in the marketing of consumer electronics in the public sector, it did not choose to commit its resources to producing the new device. Marketing in the public sector is very different from marketing in the defense sector. When marketing public technology to police departments, fire departments, schools, etc., one is faced with a highly fragmented market (over 80,000 independent jurisdictions in the United States). In this case neither the firm that developed the police communication system nor any other firm (under license) was interested in marketing the product to police departments around the country. For failure to consider the TDS, a multi-million dollar technology effort failed completely.

12.0 MARKET AWARENESS, INREACH, OUTREACH

1. What is the importance of market awareness?
 2. What processes may be used for market assessment?
 3. How does one conduct a pre-market review?
 4. What is "inreach"?
 5. What are some inreach mechanisms?
 6. What is "outreach"?
 7. How does one conduct outreach?
 8. What are some resources for awareness, inreach, and outreach?
-

Guide to Section 12.0

Section 12.1 discusses what market awareness is and its importance to T².

Section 12.2 describes the elements of a pre-market determination.

Section 12.3 briefly explains primary and secondary research.

Section 12.4 defines and describes creating internal market awareness ("inreach").

Section 12.5 describes some formal mechanisms for conducting inreach.

Section 12.6 defines creating/identifying external market awareness ("outreach").

Section 12.7(A&B) discusses both the mechanisms for conducting outreach as well as describing some outreach networks.

Section 12.8 identifies some external resources to assist the T² manager with awareness, inreach and outreach.

12.1 What Is the importance of market awareness?

- A. Market awareness is simply ascertaining by some process the need for a technology and the potential adopters. As was discussed earlier, the technology delivery system (TDS) must accommodate individuals from all areas involved in the technology transfer process, ranging from R&D specialists to adopters involved in making the technology market ready. The questions that arise are: Is there a need in the market for the technology?; and Who are the potential adopters?

Quite frequently, the government (e.g. any of the Federal agencies that sponsor R&D) through the advice of experts, decides that a new technology is necessary. After a preliminary internal analysis, partners are sought by the government. These partners may be identified from past projects or as the results of a solicitation. This process, which is a technology development effort with a specific technology transfer objective, generally has a technology push emphasis but utilizes historical data for the development of participants.

For the "normal" technology transfer case, namely where a technology has been developed and its transfer is desired, the approach is different and generally it must be more rigorous if success is to be obtained. The specific application must be defined, the competition examined, the market needs quantified and potential adopters identified.

Various schemes can be utilized to define the application area. These include using:

- * industry panels
- * internal committees
- * utilizing outside contractors

and any combination of the three. The competition and market information can be obtained primarily by use of secondary reference material found in electronic databases. It may also require doing some primary research (direct data gathering from companies and potential users) to have a complete "opportunity" profile. This market research will identify potential adopters who can be approached for possible interest in the technology.

In the technology development and transfer approach, the data gathering requirements are generally better defined than for technology transfer process. The requirement for partners in the development approach is much more critical as the project can not move ahead without the participant, whereas for straight technology transfer, good market awareness increases the potential for successful adoption.

IDENTIFYING MARKET AWARENESS

SECONDARY APPLICATION

12.2 What processes may be used for market assessment?

A. The elements of a market awareness program are:

- * Qualification of the technology**
- * Quantification of the development requirements**
- * Qualitative and Quantitative determination of the market**
- * Identification of network channels**
- * Preparation of a transfer strategy**

In section 7.9 a checklist for a potentially transferable technology was given. The output from using this or a similar evaluation (for example the output from the committee described in Section 12.1) will produce a qualitative definition of the technology. This includes application envisioned, novelty, internal champions, potential protection, time-frame etc. These data then become the input to produce a development plan. For development type transfer projects, this plan focuses on joint development requirements. For the transfer of an existing technology, the development plan requires adequate rigor and quantification so that a cost picture can be prepared for potential adopters.

Determining marketplace needs is essential. For development projects they can dictate the direction and the decision as to whether a partner will join to complete the transfer. For straight transfer of an existing technology the information is essential to enable selecting candidates with the perceived highest transfer potential. This is necessary as the number of opportunities generally exceeds the resources available for transfer.

As has been described in the document several times, and as one will discover when attempting transfers, personal interaction is important, if not essential. Time and resources don't permit seeing every possible adopter. Thus, other modes are needed. The most promising is to utilize the expanding infrastructure of technology transfer service centers. This informal network contains professionals who work directly with clients as technical assistance providers, brokers and transfer specialists. These professionals generally work for local, state and federal government sponsored organizations involved in economic development. Utilizing this network permits leveraging of resources.

The organization of all these factors into a transfer strategy (as described in section 7) will greatly improve transfer success. The strategy should answer what, who, when, and how much, and specify metrics for measuring the process. It all begins and ends with market awareness (internal and external).

PREMARKET AWARENESS INPUTS/OUTPUTS

12.3 How does one conduct a pre-market review?

- A. The sources that are available to perform an assessment of the marketplace are nearly infinite. The limiting factor is normally the availability of resources.

Data can be obtained via two mechanisms

- * primary market research
- * secondary market research

Primary research is direct data gathering. This is done through committee meetings, calling experts at universities and companies, etc. In some cases, especially for consumer products, this mechanism is the principal source of data. For non-consumer applications primary research activity extends data obtained from secondary sources.

Secondary research utilizes historical data. These may be technical or business/market data that are found in reports or electronic databases. Generally, searches are made of relevant databases (examples are given in Section 8 of the guidebook) to obtain useful background data. These data enable the T² manager (and staff) to evaluate the state-of-the-art of competing technologies, market trends and possible partners/adopters. These data help define the transfer strategy and/or the primary development requirements.

Technical libraries are excellent sources for hard copy materials and for requesting electronic searches. Contractors (both private and government supported) are available to provide these data.

MARKET RESEARCH APPROACHES

PRIMARY RESEARCH

SECONDARY RESEARCH

12.4 What is "Inreach?"

- A. Most laboratory scientists are aware of technology transfer concepts. Few, however, have a working knowledge of the process, services and potential benefits. This becomes the responsibility of the T² manager. To create this internal awareness, "Inreach" Programs are useful. Some of the components of such a program include:

- * Establishing internal transfer advocates
- * Developing training materials
- * Conducting workshops
- * Performing opportunity assessments
- * Publicizing activities
- * Providing means for reward and recognition
- * Sharing measurement data

The outcome desired by the T² manager is a flow of new technological opportunities into his/her office for processing.

Market awareness has previously been discussed. Generally, the T² manager functions in an intermediary role; he/she is neither the developer nor the adopter of the technology, rather is the facilitator from inventor to innovator.

How does the technology reach the T² manager? In some cases, management requires direct submission to the T² office. In most cases the T² office must seek technologies. Why? While law or corporate policy now requires technology transfer, actual operations vary at laboratories and companies. Generally the T² office is "staff" rather than "line" therefore, it must operate as a service center. As such it must provide good transfer support services, which include internal marketing to obtain opportunities for transfer.

INREACH

12.5 What are some inreach mechanisms?

- A. The number and types of mechanisms are limited only by one's imagination, laboratory policy and resources. A commonly used "tool" is the laboratory newsletter. Placing requests, inserting stories, doing photo spreads are common ways for communicating the T² program to laboratory personnel. Generally success stories including rewards/benefits are very effective. Photo sessions with internal management and/or with external agents can also be useful. Normally it is easier to utilize internal existing newsletters rather than attempting to create a new and/or specific one for tech transfer.

Another useful approach is to create internal technology transfer agents. These agents can be at the grass root investigator level or at line management level. The latter tend to be easier to organize but may not be as an effective publicizer as the former. One reason is that those who join at the grass roots level are motivated by the potential outcomes and are more likely to publicize the needs and results. Management quite often is operating by directive rather than by motivation.

To have an effective network, agent training is essential. This can be done in cooperation with the legal office or done separately. Training materials need to be prepared and sessions conducted. Considerable material already exists and may be obtained from various organizations (e.g. Federal Laboratory Consortium, Association for Federal Technology Transfer Executives, Licensing Executives Society, Technology Transfer Society, and Headquarters Technology Utilization Offices).

Experience indicates that training needs to be ongoing. Workshops on legal requirements, contracts, agreements, market changes, federal programs, etc. need to be given, updated and regiven. All training does not have to be done by the T² office. The Office of Personnel Management, the Oak Ridge Institute for Science Education, the National Technology Transfer Center, many private sector firms and others have programs to assist T² managers.

Finally, for the program to be successful, motivators must be introduced to overcome inherent barriers (e.g. culture, lack of management support, risk, etc.). The T² manager should be seeking and assisting intrapreneurs (those internal innovators) as well as entrepreneurs (those who show the desire to carry out innovation outside the existing corporate structure). Intrapreneurs generally can be motivated by modest support (financial and policy) from the T² office. Entrepreneurs will obtain their major reward if the innovation is successful. The T² manager can motivate them by technical and business assistance which will facilitate the transfer (and innovation process).

INREACH MECHANISMS

12.6 What is "outreach?"

- A. Businesses with products or services to sell reach their customers through sales and marketing programs. For federal laboratories, programs whose objective is to reach "customers" are often referred to as "Outreach". Similar in function to inreach, its purpose is to create awareness in the marketplace (end users and adopters) for possible technologies.

Federal laboratories have certain restrictions placed upon them relative to reaching technology transfer customers. The general mechanisms available to businesses: advertising, salesmen, trade shows, use of third parties may be restricted at a federal laboratory. Direct sales are generally not allowed.

What mechanisms can be employed? In general all of those available to businesses with the exception of direct sales are possible. The restrictions generally apply to how the technological opportunity is represented, the use of funds and the use of outside resources.

SOME OUTREACH RESOURCES

**ADVERTISING
SALES
TRADE SHOWS
BROKERS
PUBLICATIONS
CONFERENCES
PRESENTATIONS**

**AUDIENCE
OF USERS,
ADOPTERS,
CO-DEVELOPERS**

12.7A How does one conduct outreach (mechanisms)?

- A. The mechanisms for outreach are quite numerous and varied. As with inreach, selection generally depends upon laboratory policy and resources. Because the "message" is going to external sources it may require greater scrutiny and internal scrubbing. Approval schemes are highly dependent upon the laboratory.

In general three mechanisms are utilized for outreach.

- * technical publications
- * presentations (conferences, trade-shows)
- * utilization of market support groups

Technical staff of federal laboratories generally have publication and presentation requirements as part of their performance review. This means that a good share of new technological opportunities appears in the technical literature. The difficulty with utilizing this information is that technical articles and conference papers are aimed at peers and often do not fulfill the needs of the private sector adopters. Furthermore, the process of getting information scrubbed for intellectual property protection and getting it in print is a deliberate process often deterring getting information rapidly into the marketplace. Thus, other publications are quite often called for. These may be generated by the T² office (Market Bulletins), the laboratory (R&D summary), or the agency (DOE Technology Transfer Report, NASA Tech Briefs, and the NASA "Spinoff" Magazine). The T² Manager needs to seek and direct information into formats and venues that reach adopters. For example, participating in Technology Transfer Conferences, trade shows like the Federal Laboratory Consortium - Reaching the Market Meeting, NASA Tech Briefs, and the Tech 2000 Shows can be beneficial.

Attendance at technology transfer events and preparation of novel materials are helpful. Active participation by the T² staff, however, is essential to foster market awareness (internal and external).

PROCESSING OF TECHNICAL MATERIAL FOR T² OUTREACH

12.7B How does one conduct outreach (networks)?

- B. Many external sources exist to aid the T² manager. There are publications and meetings; there also are individuals and firms. Most communities, state and various federal agencies are committed to business development. This interest has resulted in a whole menu of assistance resources. For example, at the national level there are the Agricultural Extension Service, the National Technology Transfer Center, and the Small Business Administration's (SBA) Service Core of Retired Executives (SCORE); at the Regional Level there are the NASA Regional Technology Transfer Center, the FLC Regional Coordinators, and the National Institute of Standards and Technology (NIST) Manufacturing Technology Centers; at the state level there are programs like PENNTAP and the Georgia Tech Economic Development Service; at the local level almost every Chamber of Commerce has an economic development officer.

These types of programs provide the T² managers with channels for direct input and links with businesses who may be adopters of technologies.

OUTREACH NETWORKING

12.8 What are some resources for awareness, Inreach, and outreach?

- A. The T² Manager should be aware that there are two categories of databases that can be utilized:

Technical databases

(e.g. NTIS, Compendex) which can provide the technical information necessary to perform an assessment of the state-of-the-art of the technology

Market databases

(e.g. PTS Prompt, Future Technology, D&B Corporate Announcements, FINDEX) which provide secondary market research information that permit an assessment of the competition, market trends and potential adopters.

These resources can be accessed directly by the T² manager, through his/her library or by contract with information services providers.

Inreach/Outreach:

The resources available to the T² Manager are broad and varied. Most T² managers develop their programs utilizing the experience of colleague and peers. These data normally are obtained from predecessors and through attendance at professional meetings and through personal interactions.

The resources available to the T² managers are growing very rapidly making it difficult to produce a comprehensive and current listing. The following listing of organizations, publications, networks and information resources are proposed as a useful working resource base for T² managers.

RESOURCES

Societies/Associations

Technology Transfer Society (T²S)
611 N. Capitol
Indianapolis, IN 46204
v(317) 262-5022
f(317) 262-5044

Federal Laboratory Consortium
P.O. Box 545
Sequim, WA 98382
v(206) 683-1828
f(206) 683-6654

Association for Federal Technology Transfer
Executives
6003 Executive Blvd.
Bethesda, MD 20892
v(301) 496-0750
f(301) 402-0220

Association of University Technology Managers
71 East Rd.
Norwalk, CT 06851
v(203) 852-7168 or (515) 294-4740
f(203) 563-5714

Licensing Executives Society, U.S. & Canada
71 East Rd.
Norwalk, CT 06851
v(203) 852-7168
f(203) 838-5714

Association of Technology Business Councils
1953 Gallows Rd.
Suite 130
Vienna, VA 22182
v(703) 848-2800
f(703) 848-2353

Science and Technology Council of the States
National Governors Association
444 N. Capitol St. NW
Washington, DC 20001
v(202) 624-5300

Industrial Research Institute
1550 M. St. NW.
Washington, DC 20005
(202) 872-6350

Publications

NASA Tech Briefs
41 East 42nd Street
Suite 921
New York, NY 10017-5391
v(212) 490-3999
f(212) 986-7864

Washington Technology (newspaper)

Technology Transfer Business (magazine)
TechNews, Inc.
1953 Gallows Rd.
Suite 130
Vienna, VA 22182
v(703) 848-2800
f(703) 848-2353

Agency Publications

e.g. NASA Spinoff
DOE Technology Transfer

"Federal Technology Report"
1200 G Street NW
Suite 1200
Washington, DC 20005
(202) 383-2240

"Technology Access Report"
P.O. Box 2189
Berkeley, CA 94702
v(510) 549-4300
f(510) 549-4342

"Cooperative Technology R&D Report"
2065 National Press Bldg.
Washington, DC 20045
(202) 966-9610

Information Resources

National Technical Information Service
Dept. of Commerce
5285 Port Royal Rd.
Springfield, VA 22161
(703) 487-4650

Dialogue Information Services (commercial
database vendor)
3460 Hillview Ave.
Palo Alto, CA 94304
(800) 334-2564

Knowledge Express (commercial on-line federal
databases)
P.O. Box 8301
Radnor, PA 19087
(800) 248-2469

Technology Targeting, Inc. (adopter
databases)
2940 Warr Road
Salt Lake City, UT 84109
(801) 487-9800

Orbit Online Service (commercial database
vendor)
Division of InfoPro Technologies
P.O. Box 360498
Pittsburgh, PA 15251

Technology Prospects, Inc. (knowledge service)
P.O. Box 2078
Falls Church, Virginia 22042
v(703)534-8750
f(703)534-0861

Directories

State Industrial Directories
Harris Publishing Co.
2057 Aurora Rd.
Twinsburg, OH 44087
(800) 888-5900

CorpTech Technology Directory
1 Market St.
P.O. Box 81281
Wellesley Hills, MA 02181
(800) 843-8036

NERAC, Inc. (database service)
One Technology Drive
Tolland, CN 06084
(203) 872-7000

STN (commercial database vendor)
P.O. box 3012
Columbus, OH 43210
(800) 753-4CAS

COSMIC (Computer Software Management
and Information Center)
University of Georgia
382 E. Broad St.
Athens, GA 30602
v(706) 542-3265
f(706) 542-4807

ARAC, Inc. (knowledge service)
611 N. Capitol Ave.
Indianapolis, IN 46204
v(317) 262-5003
f(317)262-5044

Teltech, Inc. (knowledge service)
2850 Metro Dr.
Minneapolis, MN 55425
(612) 851-7500

Federal Laboratories Directories
P.O. Box 545
Sequim, WA 98382
(206) 633-1005

Thomas Register of American Manufacturers
One Penn Plaza
New York, NY 10117
(800) 222-7900

Network Resources

National Technology Transfer Center (NTTC)
Wheeling Jesuit College
316 Washington
Wheeling, WV 26003
(800) 678-NTTC

NASA Regional Technology Transfer Centers (RTTC)

Far West RTTC

University of Southern California
3717 South Hope St., Suite 200
Los Angeles, CA 90007-4344
v(800) 872-7477
f(213) 746-9043

Mid-Continent RTTC

Commercial Technology Services
Texas Engineering Experiment Station
The Texas A&M University System
310 Wisenbaker Engineering Research Center
College Station, TX 77843-3369
v(800) 548-1536
f(409) 845-0106

Mid-West RTTC

Battelle Memorial Institute
Great Lakes Technology Transfer Center
25000 Great Northern Corporate Center
Suite 450
Cleveland, OH 44070
v(216) 734-0094
f(216) 734-0686

NIST Manufacturing Centers

NEMTC

Northeast MTC
RPI CII Rm. 9009
Troy, NY 12180
v(518) 276-6314
f(518) 276-2990

SMTC

Southeast MTC
P.O. Box 1149
Columbia, SC 29202
v(803) 252-6976
f(803) 252-0056

Northeast RTTC

Center for Technology Commercialization
Massachusetts Technology Park
100 North Drive
Westborough, MA 01581
v(508) 870-0042
f(508) 366-0101

Mid-Atlantic RTTC

Mid-Atlantic Technology Application Center
University of Pittsburgh
823 William Pitt Union
Pittsburgh, PA 15260
v(412) 648-7000
f(412) 648-7003

Southeast RTTC

Southern Technology Application Center
University of Florida
College of Engineering
Box 24, One Progress Boulevard
Alachua, FL 32615
v(800) 225-0308
f(904) 462-3898

UMMTC

Upper Midwest MTC
111 third Ave. S., Suite 400
Minneapolis, MN 55401
v(612) 338-7722
f(612) 339-5214

GLMTC

Great Lakes MTC
4600 Prospect Ave.
Cleveland, OH 44103
v(216) 432-5300
f(216) 361-2900

MMTC**Midwest MTC**

P.O. Box 1485
2901 Hubbard Road
Ann Arbor, MI 48106
v(313) 769-4377
f(313) 769-4064

MAMTC**Mid-America MTC**

10561 Barkley, Suite 602
Overland Park, KS 66212
v(913) 649-4333
f(913) 649-4498

Training and Education

Office of Personnel Management (OPM)
Western Executive Seminar Center
1405 Curtis St.
Denver, CO 80202
(303) 623-4140

Oak Ridge Institute for Science Education
(ORISE)
P.O. Box 117
Oak Ridge, TN 37831
(615) 576-3000

Miscellaneous**Metrics**

Chapman Research Group Inc.
5601 South Broadway, Ste 306
Littleton, CO 80121
(303) 730-2226

Brokering Conference

Technology Transfer Conferences, Inc.
325 Plus Park Blvd., Ste 108
Nashville, TN 37217
(615) 366-0680

CMTC**California MTC**

13430 Hawthorne Blvd.
Hawthorne, CA 90250
v(310) 355-3060
f(310) 676-8630

National Technology Transfer Center (NTTC)
Wheeling Jesuit College
316 Washington
Wheeling, WV 26003
(800) 678-NTTC

Exposition

Tech 2000 Series
Technology Utilization Foundation
41 E. 42nd St.
New York, NY 10017
(212) 490-3999

REFERENCES AND SOURCES

A. GENERAL REFERENCES

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

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Dr. F. Timothy Janis

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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, 10.6

Audiences, 1.1, 1.3, 4.0

- as Actors, 4.1, 4.8

- Participation, 7.4

- Primary, 2.2, 4.0, 4.4, 5.5, 6.7

- Secondary, 2.2, 4.4, 5.5, 6.7

- Size of, 6.7

- Target, 2.4, 4.0, 4.8

Awareness, 2.3

Barriers, 1.4, 2.2, 2.3, 4.5, 4.11, 7.1

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

- T² Agents, 7.10

- T² Methods, 7.13

Clearinghouse, 2.3

Commercialization, 1.2

Communications Problems, 1.4, 2.3

Competition

- Among Industries, 5.6, 6.2

- Within Government, 6.5, 7.8

- See Technology, Competing

Constituency, 2.2, 6.4, 6.5, 7.4

Construction Grants, 3.3

Copyright Law, 10.4

Cost-Sharing, 3.3

CRADA, 9.5

Demand Pull

- See Market Pull

Demonstrations, 3.3, 6.7

Department of Agriculture, 9.2, 9.3

Department of Commerce, 2.8, 9.3

Department of Defense, 1.2, 2.8, 3.1, 6.6, 9.2, 9.3

Department of Energy, 1.1, 1.2, 9.2, 9.3, 9.4

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

- Risks, 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

- to Industry, 5.8

- to R&D, See: R&D Program

Firm, size of, 6.3

Foreign National Law, 10.7

Futures Casting, 4.5, 7.8, 7.9

High-Tech, 6.3

Incentives, 2.3, 3.3, 7.3, 9.6

Industry

- High-Tech, 6.3

- Low-Tech, 6.3

- Maturity, 6.3

Industry (continued)

- Size of, 6.3

Information

- Dissemination, 1.3, 3.3, 5.0, 5.7, 7.3
- Flow, 2.3, 4.9, 7.13, 8.0
- Processing, 2.3, 2.4, 2.8, 4.3, 4.6, 4.11, 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

Inreach 12.3

Insurance, 3.3

Integration, 3.8, 3.9, 6.8, 7.11

Intellectual Property, 10.1, 10.2

Interagency Agreements, 6.6

International Law, 10.7

Inventor

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

Learning Curve, 4.11, 6.4

Leases, 3.3

Legislation, 9.2, 9.6

Life Cycle Costs, 6.7

Loan Guarantees, 3.3

Management

- Functions, 2.2, 2.9, 7.1
- Incentives, 7.13, 9.6
- 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
- See: Planning T² Budgets

Market

- Analysis, 2.3, 3.3, 4.11
- Assessment 12.3
- Awareness 12.2
- Penetration, 4.6
- Pull, 2.1, 2.6, 2.7, 6.7
- Size, 6.2

Matching Technology Needs, 1.3, 2.1, 2.3, 2.5

- Costs of, 3.1

- Risks in, 1.4

Media, 7.13

Mediation, 1.4

Mission, 1.2

Modes, 3.1, 3.4

- See: T² Modes

Monitoring, 7.5

NASA, 1.2, 3.1, 9.3

National Security, 2.8

Networks 12.16

Outreach 12.14

Passive Mode, 3.1, 3.5

Patents, 3.3, 10.1, 10.2, 10.3, 10.7, 10.8

Planning

- 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
- National T², 9.1
- DOE, 9.4

Private Sector, 1.2, 5.6, 9.2, 9.5

R&D Consortia, 6.2, 6.3, 10.6

R&D Program

- Feedback to, 3.1, 5.7, 5.8
- Interaction with, 1.2, 5.6, 5.7, 6.6
- Legislation, 9.2

Readiness for Transfer

- See: Technology Readiness

Regulations, 1.4, 3.3, 9.2, 9.4

Risks, 4.11

Semi-Active Mode, 3.1, 3.6

Social Benefit

- Capture of, 2.3, 6.2

Spin-off, 1.2, 2.3

Standards, 3.3

Strategy, 7.3, 7.6, 7.7

Systems Integrator, 6.6

Technical Assistance, 6.2, 6.5, 9.2

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
- End-User, 4.4
- Evaluation, 2.3
- Maturity of, 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, 5.6, 5.7, 6.2
- Service Life, 6.2
- Sub-Economic, 6.4
- Usefulness, 2.3, 5.3, 5.4, 5.5, 7.10
- 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

Technology Delivery System

- Definition, 1.1, 2.5
- Analysis of, 4.5, 4.7
- Complexity, 4.3
- Examples of, 4.3, 4.4
- Models, 11.2, 11.3

Technology Transfer Agent, 2.1, 2.4, 2.6, 4.8

Technology Utilization, 1.2, 1.3

Trademark Law, 10.5

Trade Secrets, 10.3

Uncertainties, 4.11