Information Systems Related to Technology Transfer: A Report on Federal Technology Transfer in the United States

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INFORMATION SYSTEMS RELATED TO TECHNOLOGY TRANSFER

A Report on Federal Technology Transfer
in the
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EXECUTIVE SUMMARY

This report examines all aspects of domestic technology transfer in the United States. The introduction provides a perspective on meanings of technology transfer, its importance to the economic development of the Nation, and legislative initiatives concerning the process. The overview of Federal support for Research and Development (R&D) describes the prominent agencies and cross-cutting organizations principally involved in technology transfer and their programs and information systems. Most Federal R&D programs produce technical documentation and publications, some of which are also provided in printed form to the National Technical Information Service (NTIS). These same agencies are cooperating with the National Technology Transfer Center (NTTC) to consolidate the information systems resources in electronic format to make them readily accessible to business and industry.

Commercial technology transfer programs provide a wide range of services ranging from on-line access to more tailored hands-on approaches. Some of these commercial services add value to the technology transfer process via interaction with technical analysts (as does the NTTC). Commercial programs are more suited to large companies as the rates for their services are usually beyond the capability of many small businesses to afford them.

There is a significant amount of cooperation among the major Federal R&D Agencies, the Federal Laboratory Consortium, and the Federal Laboratories in providing resource information to the National Technology Transfer Center. The capabilities of the laboratories to follow through on requests, however, are hampered by insufficient funding and mission priorities.

Options for enhancing the technology transfer process lie not with the establishment of more programs, but rather with support for the effective ones that are in place. This includes continued support of the NTTC in its role of becoming a “one-stop-shop” to access the Nation’s technology and in providing better support for the infrastructure elements such as extension programs and entrepreneur centers who can provide the expertise and linkages to support commercialization activities of small and medium sized business and industry,

INFORMATION SYSTEMS RELATED TO TECHNOLOGY TRANSFER

A Report on the Organizations, Mechanisms, and Barriers
to Technology Transfer
in the
United States

INTRODUCTION

The Federal government will spend approximately $70 billion for Research and Development (R&D) this year through Federal laboratories, universities, and companies. This vast expenditure of resources addresses virtually every area of science and engineering. Harnessing the leading edge technology developed by this investment can be a major factor in driving the engine of the National economy and bolstering America's competitive posture in the international marketplace.

While this technology may seem to be readily available for commercial use, there are many barriers that prevent its easy movement from the Federal to the Private Sector. Among those barriers are a lack of awareness of the R&D, a misunderstanding of its potential applications to commercial use, a means to access technology information, and the capital to fund the commercialization process. These barriers are compounded by others such as issues with intellectual property rights, concern for national security, and institutional barriers.

"Technology Transfer" is a complex topic that has various meanings to different audiences, To industry it could mean loss of proprietary technical information to a competitor or the licensing of a new technology which could be used to increase productivity or introduce a new product. To the military or the state department, it could be connected with helping an ally to introduce advanced weapon systems for cooperative defense; but is more likely to be construed as meaning the loss of a national security-sensitive technology to a potential adversary via espionage or a breach in security,

In the purest sense of the meaning, Technology Transfer is the process by which technology, knowledge and/or information developed in one organization, for one purpose is applied and utilized in another organization, in another area, for another reason.

For Federal organizations, this could mean:

- Use of technology from outside the government for a government purpose (Technology Infusion)

- The movement of technology developed by one Federal agency to use in another (Technology Transfusion), or

- The movement of technology from the Federal government to the private sector (Technology Diffusion). When applied to American business and industry only, this is most commonly known as Domestic Technology Transfer.

This report focuses on the process of Federal Domestic Technology Transfer and the organizations and mechanisms that foster this process. It discusses the barriers in detail, and discusses options for improving the process including the case for a centralized, user friendly, information system.

UNDERSTANDING THE TECHNOLOGY TRANSFER PROCESS

It is not easy to transfer Federally-sponsored technology from the laboratory and innovator's workbench to the marketplace or public sector programs.

The Philosophical Gap Between Government and Industry

One of the most fundamental barriers is the philosophical gap between the missions of the federal scientific and technical community which does R&D and the motivations of the private sector companies and entrepreneurs who would invest in the commercialization of products and processes which could result from that R&D.

Being more technologically-driven organizations, the federal laboratories and scientific and technical centers make large investments in research and development facilities and have a primary interest in achieving and maintaining a technological superiority. With these goals in mind, they develop technology as the main source of their activities and establish a technology base long before they have a product application.

Being more market-driven, by contrast, private sector companies and entrepreneurs tend more to analyze current and secondary markets in order to predict what types of products will yield a high profit. Based on these analyses, they then develop focused product concepts and make the required investments to produce them.

Because they operate based on different drivers, federal research and development centers and private sector companies frequently talk at each other rather than to each other. The federal research and development centers, being more technologically driven, need not have commercial product divisions, nor are they

required to understand the makeup of private sector markets. However, if they want to make the technology transfer process work, they must actively solicit the interest of private sector firms that not only have commercial product divisions but also desire to make products that will be profitable. Because of this difference in orientation, it is frequently difficult to establish the lines of public-to-private sector communication needed to transfer technology.

Complicating this communication problem are barriers inherent in the transfer of federally-funded technologies to other public sector programs. These include bureaucratic inertia, a lack of up-to-date information about research activities funded through that federal agency's programs, and intellectual property issues associated with the release of proprietary information about products and processes developed by contractors for that agency.

These barriers--the different drivers motivating public and private sector research and development organizations and the problems associated with public-to-public sector technology transfer efforts--strike at the heart of the challenge Federal agencies face in working to transfer sponsored technologies to the private sector and end-use conservation programs, To bridge these gaps requires a people-to-people technology transfer approach which gets the potential consumer, those groups or individuals with a requirement that can be filled with a Federally-funded technology, to speak with the supplier of that technology, the laboratory or innovator who received Federal funds to do the research and development work required to create the technology.

National Concern and Initiatives

Traditionally, technology transfer from the Federal Government to industry and especially small business has been a challenge due to many factors. There is a general lack of awareness among many small and medium sized companies of the benefits that new technology could bring to the productivity of the company or in creating new product lines. Even with a general awareness that Federal laboratories and other agencies spend billions of dollars annually in research and development, the perception persists that the resulting technology base is of little use to the private sector. Compounding these barriers is a general problem with accessing technology due to the size and dispersion of federal agencies, laboratories, and resources; security and intellectual property issues; and the accompanying reluctance of business to deal with the bureaucratic elements of government.

- Congressional Initiatives

The Congress, keenly aware of these issues, has recently enacted a number of legislative initiatives to foster the transfer of technology from the Federal government to the private sector. Most of this legislation has focused on measurable means of technology transfer such as the number of patents issued, license agreements signed, or Cooperative Research and Development Agreements (CRADAs) established. While these mechanisms of technology transfer are primary tools, there is a great amount of evidence to support the fact that American business and industry also need access to the expertise in government to help them answer technical questions that do not require the cumbersome process associated with intellectual property protection and cooperative agreements.

In an attempt to help technology transfer efforts, the Congress and the Executive Branch have taken a number of steps to create law and policy to break down the barriers. These include!

- The Stevenson-Wydler Technology Innovation Act of 1980
- Patent and Trademark Amendment Act of 1982 (Bayh-Dole Act)
- The Small Business Development Act of 1982.
- The Federal Technology Transfer Act of 1986 (FTTA).
- Presidential Executive Order 12591, of April 10, 1987. “Facilitating Access to Science and Technology”
- The Omnibus Trade and Competitiveness Act of 1988
- The National Competitiveness Technology Transfer Act of 1989
- Provisions of the Defense Authorization Act for FY 1991
- The Small Business Technology Transfer Act of 1992
- Provisions of the Defense Authorization Act for FY 1993

- Administration initiatives

The last administration promoted the use of Federal technology for commercial applications through the National Technology Initiative (NTI). This effort involved cabinet-level briefings and conferences throughout the country to encourage the interaction of business and industry with the federal agencies and laboratories. The conferences indicated a high level of interest on the part of industry to cooperate with Federal agencies in R&D, but also indicated that for success, the research needed to be complimented with manufacturing excellence, the availability of investment capital, and aggressive marketing on the part of government agencies. The NTI report indicated a need to improve access to technology, to overcome the bureaucratic and institutional barriers, to improve the availability of long-term patient capital, and support programs that foster

manufacturing excellence[2]. The NTI reportedly forged a stronger public/private partnership for technological competitiveness and formed the basis for subsequent action on a range of issues important to the innovation process. It created a wider awareness of the existence of technology available for commercialization from the Federal government and laid groundwork for future efforts of the next administration.

One of the current administration's first policy declarations was "Technology for America's Economic Growth, A New Direction to Build Economic Strength"[3]. This policy signaled a major change in the support of the government for activities such as technology transfer as a key element in America's economic future. The current Technology Reinvestment Project', based on provisions of the FY 93 Defense Authorization Act, focuses directly on this issue with the involvement of the five primary Federal R&D Agencies.

Thus, the interest in technology transfer and commercialization has blossomed from a little known entity to a major visible element of National Economic Policy. Given the existence of the technology and the legislation to promote its use, it would be useful to next examine the processes for technology transfer.

TECHNOLOGY TRANSFER PROCESSES

Technology Transfer activities are generally categorized as either Technology Push or Market Pull. Technology Push is the solution in search of a problem, while Market or Requirements Pull addresses a problem in need of a solution. The latter is generally a much more successful approach to initiating technology transfer activities.

Technology-Push Processes

Technology-push methods are used to facilitate the people-to-people aspect of the technology transfer process. This is done by identifying technologies already developed for Federal Agencies and providing the interested party with information about these technologies, This information is supplied to initiate a process whereby that party can contact the developers of the technologies to find out if the emerging Federal technology of interest can be used in the research, development, or commercialization of other new products or processes.

Technology-push mechanisms used in this process may include the development of database referral services which provide information about current federally-funded efforts and their applications for other private and public sector purposes. Outreach programs can also be established which publish newsletters, brochures,

and reports that publicize Federal technology transfer services or describe new Federally-developed technologies and their applications for other research, development, and commercialization efforts.

Market-Pull Technology Transfer

Market or Requirements-pull methods of technology transfer involves the analysis and assessment of uses and markets for Federally-funded technology. Using these methods, Federal Agencies can evaluate and determine what will make their sponsored technology more attractive to the individual or organization using it for other private or public sector requirements. This can be done by matching existing technology requirements that potential consumers might have with a set of Federally-developed technologies that can be integrated or customized to meet those requirements.

Market-pull methods used in this process can include the organization of conferences and advisory panels that meet to review technology efforts coming from Federally-funded projects; identify potential applications for these technologies to the private sector and federal, state, and local government agencies; and provide guidance on the means by which this transfer takes place. These advisory panels may include panelists representing such diverse communities as academia, industry, professional associations, research institutes, and the federal R&D establishment.

State and Regional Facilitator Programs

The interface between technology transfer programs and State, local, and regional economic development programs is an essential part of technology transfer. Interaction and leverage with organizations such as Small Business Administration-supported Small Business Development Centers (SBDCs), State extension programs, university entrepreneurship centers and incubators, technology councils, and state economic development organizations provides a superior infrastructure for Federal technology to reach small and medium sized businesses throughout the nation. These organizations have the highest potential to be facilitators in technology transfer, yet many of them are not knowledgeable in the essential elements of technology development and commercialization. Many also lack staff trained to understand client's technical needs or to search out potential sources of assistance in the Federal government.

Mechanisms

There are numerous mechanisms for technology transfer employed by the Federal Agencies, Laboratories, and Centers. Not all organizations employ or exploit every mechanism. The most well known mechanisms include:

- Cooperative Agreements - instruments entered into by the government with industry, universities, and others to support or stimulate research; agreements are cost-shared with the non-federal participant.

- Cooperative Research and Development Agreements (CRADAs or CRDAs) - agreements formed under the provisions of the FTTA between government and non-federal parties in which both participants provide personnel, services, facilities, or equipment for the conduct of specified R&D, The non-federal parties may also provide funds (no direct funding is provided by the laboratory or center). Rights to inventions and other intellectual property are negotiated between laboratory and participant, and certain data may be protected from disclosure for up to five years.

- R&D Consortia - multiple federal and non-federal parties working together for a common R&D objective, Funding for R&D consortia may be shared, but usually no funds are exchanged between participants.

- Exchange Programs - arrangements allowing government or laboratory staff to work in industry facilities and industry personnel to work in government laboratories to exchange technical capabilities and support research in specific areas. Costs are borne by the organization sending the personnel. Intellectual property arrangements can be addressed in exchange agreements.

- Patent Licensing Agreements - the transfer of less than ownership rights in intellectual property, such as a patent or a software copyright, to permit its use by the licensee. Licenses can be exclusive or non-exclusive, for a specific field of use or for a specific geographical area. The potential licensee usually must present plans for commercialization. In many cases, such action can result in the creation of a new “spinoff company” which is based solely on the licensed technology. Examples of this rapid commercialization can be found in the 22 new companies spawned over the past six years through licensing of technology produced by the Strategic Defense Initiative.

- **User Facility** Agreements - arrangements permitting private parties to conduct R&D in a laboratory. For proprietary R&D, the laboratory is paid for the full cost of the activity. If the work will be published, cost can be adjusted. Intellectual property rights generally belong to the user.

- Work-for-Others - agreements whereby proprietary work for an industry may be conducted by technically qualified government laboratory staff using laboratory facilities with the full cost charged to the client industry. The intellectual property generally belongs to the industry sponsor. The government usually retains a non-exclusive, royalty-free license to such intellectual property.

- Small Business Innovation Research (SBIR) Program - mandated under the Small Business Innovation Development Act, and its reauthorization under P.L. 99-443 and PL 102-564, the SBIR programs are specifically oriented to technology transfer. The following agencies are currently participating in the SBIR program:

  - Department of Agriculture
  - Department of Commerce
  - Department of Defense
  - Department of Education
  - Department of Energy
  - Department of Health and Human Services
  - Department of Transportation
  - Environmental Protection Agency
  - National Aeronautics and Space Administration
  - National Science Foundation
  - Nuclear Regulatory Commission

  Phase lll of the SBIR Program is specifically oriented toward the commercialization of the technology developed in phases I and II for government purposes. These technologies make up a significant part of the national technology base and should be considered fruitful areas for Federal Technology Transfer Programs,

  Information on SBIR-sponsored technology available for commercialization from all Federal programs is made available through the NTTC.

- Small Business Technology Transfer Pilot (STTR) Program

  The new STTR Program, mandated under PL 102-564, specifically provides for a process similar to the SBIR program for the commercialization of Federally-sponsored technologies. The objective of this program is to involve small businesses with not-for-profit organizations in licensing new Federal technologies and commercializing them into products and processes for industry. This program becomes effective in FY 94, and agencies affected are currently developing implementing policies and procedures.

- Demonstration Projects - funded by technology transfer organizations including regional FLC managers to show the viability of a process, procedure, or outreach mechanism for technology transfer. These may involve cooperative agreements with state, local or regional economic development groups, universities, small businesses, or not-for-profit organizations,

- Professional and Trade Associations - these organizations provide access to audiences with interests in specific types and applications of technology. Interface between technology transfer managers and these organizations provides a capability to combine the best features of Market Pull and Technology Push activities,

Supporting Organizations and Associations

There are several organizations which support the profession of technology transfer.

- The Technology Transfer Society is the National organization with chapters across the country who focus on the professional development of Technology Transfer managers. The T^2 Society provides its members with a monthly newsletter, a quarterly journal, an annual symposium, a directory of members, and reduced rates on selected professional books and periodicals related to technology transfer.

- The Association of Federal Technology Transfer Executives (AFT^2E)is a newly formed organization that supports activities oriented toward professional development which supplement the training and networking activities of the FLC,

FACTORS INFLUENCING THE EFFECTIVENESS OF TECHNOLOGY TRANSFER

Barriers to technology transfer

There are a number of barriers which must be overcome in successfully transferring technology from the Federal Government to the private sector. These barriers can best be seen from the perspective of the two groups. It is acknowledged that most of these issues are perceptions, but when it comes to technology transfer, perception on the part of the private sector is the major challenge.

Private Sector Issues

- **Awareness**

From the perspective of the private sector, there is little awareness of the technology available from the Federal government and a poor perception of how it could apply to the needs of most businesses and industry. To address the awareness issue, it is paramount that technology transfer programs pursue a proactive outreach program, using all means available to reach potential users of advanced technology.

- Poor Perception of Commercial Applications

Both the general public and business have **a** poor perception of the value and application of Federal technology, especially that which comes from Defense and Aerospace-related R&D. The technologies are deemed as too sophisticated and expensive to have basic applications, even though programs as the Strategic Defense Initiative have spun off such practical applications as air bag switches, brighter brake lights, and higher efficiency spark plugs for automobiles to better medical imaging diagnostics,

- Access

Up until recently, access to new technology information was hampered by the diversity and dispersion of information throughout the Federal government. Industry could obtain technical reports from NTIS, but for the most part, the leading edge technology developed by the DOD, DOE and NASA was not available to those who did not have an existing contract with these agencies. The FLC attempted, though its Administrator function, to make referrals to the appropriate federal laboratories which had expertise in a given area. The ORTA staff at these

laboratories relied on their phone directories and personal knowledge of what research was being done in the lab , but there was no consolidated information system that contained a full range of R&D and technology from the Federal laboratories. For the most part, industry - especially that which was not defense-related - was left out in the cold in terms of accessing most of the advanced technology so important to its advancement.

In the latter part of the 1980's, with the advent of the FTTA and advancements in computer capabilities, various organizations began to develop information systems internally which cataloged various R&D efforts and technology. With these developments, many of the agencies relied then, and even today on paper publications to disseminate information on R&D and technology. The capability of business and industry to quickly find technology and expertise, whether assisted or through computer access, is only a very recent phenomena.

- Size, Diversity, and Dispersion of Federal Agencies and Laboratories

Another barrier to technology transfer from the perspective of industry is the vast diversity and geographic dispersion of Federal resources. Companies (particularly small businesses) are more prone to work with an laboratory which is in their neighborhood than one on the other coast, If the laboratory in the neighborhood happens to deal in technology that is applicable to the business, there is a chance for collaboration, If not, the virtual size and dispersion of the Federal laboratory system is a major deterrent,

- Not Invented Here (NIH)

Pride of ownership, while it may not be practical, plays a major role in deterring the adoption of new technology. Especially in large corporations, the perspective is that internally-generated inventions and technology are far superior to whatever could be created in some government laboratory.

- Intellectual Property Concerns

Rights to inventions and technology are a principal factor in deterring technology transfer, The process starts when companies, under federal contracts, create a new technology and do not disclose it so that it can be retained for internal use. Government enforcement of disclosures under Federal contract provisions is poor, thus much new technology is retained and not disclosed by corporations unless there is a proactive attempt on the part of the government sponsor to help in the spin-off and application of the technology to other markets.

Government claims to royalty-free use of technology developed in cooperative efforts is also a deterrent to many companies and investors who perceive that their investment in a cooperative venture may not have enough pay-off if it must be shared with the Government.

- **Reluctance to Deal with Federal Government**

Willingness to deal with the Federal bureaucracy, in the face of mountains of paperwork, legal clauses, lengthy processing times, and bureaucratic attitudes are a major deterrent to small and medium size businesses. For this reason, extension activities, professional and trade associations, and small business centers are the most effective ways to reach the “grass root” companies of America.

* **Financing**

By far, the most significant issue in any commercialization effort is financing. The availability of investment capital is the primary determinant in any commercialization effort. Perspectives of large corporations are based on short-term return on investment, thus they are loathe to invest in potentially risky, long-term technology adaptations based on a technology not created within the corporation. Small businesses simply may not have the capital resources to invest in new technology commercialization. For these reasons, any attempt at technology transfer must be based on a sound business plan which includes a market assessment, intellectual property protection, and a commercialization plan which addresses every phase of the commercialization process.

- Understanding the Innovation Process

Another significant barrier to successful technology transfer and commercialization is a lack of understanding of the complexity of the innovation process, especially by small businesses, Most technology available for transfer from the Federal government is in the pre-product stage and requires a considerable amount of technical expertise, investment, marketing, and sound business management to bring it to the marketplace[s] (see Appendix C). Most technology transfer facilitators (staff of SBDCs, MTCs, etc.) do not have a sufficient understanding of the process to permit them to give adequate assistance to small business entrepreneurs who may wish to develop a new technology into a product.

Federal Agency/Laboratory Issues

- Mission Priority

Much of the time, the ability of a Federal Agency or Laboratory is hampered by the basic fact that the primary mission precludes the investment of time or resources to adequately respond to the demands for technology transfer activities. This institutional barrier of primary mission conflict is especially apparent in DOD and some DOE laboratories. Based on the recent internal study, even many NASA activities do not perceive that technology transfer is a primary responsibility. Some of the larger laboratories and centers have recognized the importance of technology transfer to their own survival in the new economic environment and more are beginning to see the relevance and importance of this activity to the economic survival of the Nation.

- Funding

Funding of activities is, of course, the major factor in allocation of resources to technology transfer activities. Laboratory ORTAs have been traditionally under-funded and understaffed to provide adequate support for technology transfer activities. In many cases, the single individual assigned to perform ORTA functions has other responsibilities as well, including management of SBIR activities, public affairs, and/or information security functions. Often these jobs create a conflict of interest between disseminating information to the public while being responsible for protecting it, Even at the top levels of management in technology transfer, the individuals responsible for policy and implementation of programs at the Secretariat level in several branches of the military are not provided with adequate staff, support or travel funds.

Funding of CRADA expenses within the laboratories is not consistent across agencies, DOE, for instance, designates laboratory funding to support CRADA efforts that covers salaries, use of facilities, etc.; some DOD activities do not. This disparity causes an imbalance in the effectiveness of technology transfer efforts among agencies and is a deterrent to technology transfer in agencies where the private sector CRADA partner must pay for dedicated government personnel and other expenses.

- Security Issues

Security concerns form a major barrier to technology transfer from the DOD and parts of the DOE and NASA. To most agencies and offices in the Pentagon,

"Technology Transfer" literally means the leakage of vital military technology to potential adversaries and thus, most offices with "technology transfer" in their mission are there to prevent it from happening. Almost every report and publications from the DoD dealing with technology transfer up until very recently has focused on stories of espionage and the constant threat to our security by overt and covert actions of our potential adversaries.

Classified programs in DoD and DOE automatically create a mind set that all elements and technical developments within a classified program are also unequivocally classified. While the many components and subsystems of a military or nuclear system contribute to the overall system, many in and of themselves are not and should not be classified when broken out from the system. More appropriately, the subsystem and components - or perhaps the processes used to create them - should be properly protected, but not necessarily by classification. Designation as a military or space critical technology to prevent export is much more appropriate and also facilitates transfer of the technology to other unclassified applications in Federal programs and the private sector while still protecting the technology from leaking off shore. This can easily be accomplished under legislation and policy established for the export control of militarily critical technology established by Congress in 1983[6].

- Institutional Barriers and Culture

A final consideration regarding the effectiveness of technology transfer in any federal agency is the culture of the agency itself. While the defense agencies are couched in a culture of secrecy with regard to technology sharing, other agencies have different perspectives,

While success of technology transfer in the DoD is limited by the institutional mindset and culture, this is not a unique situation to the DoD. Cultural perspectives on technology transfer vary among federal agencies. To illustrate, it is interesting to look at the perspective of the medical research community associated with NIH. Before the FTTA of 1986, academically-oriented NIH scientists shared the fruits of their research freely with non-profit organizations, universities, and industry without regard to the legalities of patents and license agreements. With the advent of the FTTA, scientists and researchers were burdened with a bureaucratic process that they found to be complicated, poorly understood, and too legalistic. Most of the scientific community reacted with a "too hard to work" attitude toward the FTTA requirements and continue to believe that this new legislated bureaucracy hinders technology transfer, scientific research, and the free exchange of ideas in an academic environment.

University technology transfer programs face other cultural issues and institutional barriers. The primary perspective of university faculty is to research, not develop products. The focus is to fund long term research programs that support graduate students and faculty members over several years. This mindset directly conflicts with the objectives of some state economic development organizations who attempt to fund cooperative R&D programs through universities. Businesses want fast results - Academia wants to study the problem. Academia needs to "publish or perish" - Industry wants to have intellectual property rights before it makes large investments in commercialization activities. Also, it must be recognized that university technology is very embryonic. Industry looks for ready-to-market technology only to be disappointed that considerable development and investment is needed to take the technology through the prototype to the market. For this reason, the effectiveness of technology transfer programs from universities are somewhat hampered, yet many do succeed in spite of the odds.

- Bureaucratic Barriers

In addition to institutional and cultural barriers, the basic bureaucratic processes related to technology transfer are formidable. Concerns about conflict of interest, micromanagement of laboratory activities, legal concerns, negotiations over potential value, exclusive rights, and other factors cause significant delays and considerable legal expense to the transferee in the processing of CRADAs and license agreements. Often the time required to process is sufficient to miss a major market penetration opportunity. Most prominent in the bureaucratic process is DOE, whose centralized CRADA administration activities have drawn criticism and led the GAO to conclude that "Despite the strong motivation by DOE's headquarters to control the CRADA implementation process and to ensure the laboratories' survival, the centralized process of implementing a CRADA appears to have left the considerable technology transfer potential of the technical resources at DOE's laboratories unrealized ".'

- Technical Barriers

Technical barriers to information dissemination with regard to technology transfer have all but disappeared in the last decade due to the advancement of computer-based information technology. Today, data bases of information are maintained in electronic format by virtually every agency, even if the data is in the form of publications. Even the existence of two industry standards (DOS vs Apple) no longer causes a problem in integrating data. Powerful search software has been developed and is in use to rapidly scan millions IS of documents for keywords, phrases, and combinations of information. Access to these systems is easily obtained via computer modems which have become an embedded component of

most PC's on the market or can be added inexpensively. Even if the information is only available in printed form, scanning technology can easily convert it to computer formatted information which can be indexed, stored, and retrieved by retrieval software.

Access by Personal Computers with modems have revolutionized information flow. Any individual with a modem-equipped PC has a preponderance of data bases, information services, and bulletin boards available free or at nominal cost which can provide access to almost any type of information.

Having the information readily available in a searchable system, however is only one step in making it accessible. Most corporations and small businesses are not trained in searching for information and can easily be overwhelmed by the volume of information available. Also, there is still a large percentage of the adult population which is computer illiterate. For these potential users, seeking technology and assistance through an intermediary such as a Small Business Development Center, a Regional Technology Transfer Center, or commercial assistance service can be more effective than long, perhaps fruitless search efforts, on-line. For this reason, the federal data bases and systems serve the assisting organizations better than the general public, and the service organizations play an important role as an intermediary. Documents, such as those available from NTIS, are also more appropriate for these clients.

OVERVIEW OF FEDERAL SUPPORT FOR R&D

The research and development activities of the United States Government are vast and diverse, touching almost every conceivable area of technology that contributes to what is known as the National Technology Base. The sources of this technology come from both internal R&D programs conducted at the Nation's many R&D Centers and Laboratories and from the external R&D conducted through contracts and grants at American as well as foreign corporations and universities.

it is important to note, when considering technology transfer issues, that many Federal R&D activities are mission-oriented and are not in existence to produce spin-offs for commercial purposes. This is particularly true of the DOD, some DOE programs and NASA. Other agencies, such as the Environmental Protection Agency and the Federal Aviation Administration are regulatory in nature, therefore their R&D is also mission-oriented.

The technological resources of the National Technology Base include not only the technology itself, but also the expertise and know-how of thousands of scientists, technicians, and technical managers, A third element of this base is the diverse

number of unique laboratory and testing facilities that is also a part of the Nation's technological resource. All these resources - technology, expertise, and facilities - are elements in the technology transfer equation and the key to America's technological and economic strength as well as its National security.

Because the elements of this national resource are centered in a number of agencies as diverse as the technologies they spawn, the most effective way to describe the Federal support for R&D and the information that is associated with it is by examining the principal agencies involved and the programs that each has in place to carry out technology transfer. These programs, in general, all attempt to address the barriers to technology transfer and some are more effective than others due to the effects of mission and culture.

Every agency in the United States Government that sponsors R&D has some programs in place to systematically collect information on the technology produced. The majority of the agencies use the data and report collection capabilities of the National Technical Information Service (NTIS) to collect and provide the public with access to the technology that they generate. There are a few exceptions: The Department of Defense, which is concerned with National Security Issues; the Department of Energy which also has a concern with nuclear security issues; and the National Aeronautics and Space Administration, which has a concern about Aerospace critical technology. Because of their missions, and the need to protect mission critical technology from public disclosure and adverse "technology transfer" to potential adversaries, these agencies have their own collection and documentation programs that are described below.

Two other driving forces in national technology transfer are The National Technology Transfer Center (NTTC) and the Federal Laboratory Consortium (FLC). These organizations work closely together to simplify access to federal technology, expertise, and resources throughout the federal system. The NTTC and the FLC are described in further detail in the next section.

CROSS-CUTTING TECHNOLOGY TRANSFER ORGANIZATIONS

The National Technical Information Service (NTIS)

The results of Federally-funded R&D are documented in tens of thousands of technical reports and papers each year. The primary repository responsible for collecting those reports that are public-releasable (not military or space critical, or classified) is the U.S. Government's central technical information clearinghouse, the National Technical Information Service of the U.S. Department of Commerce.

NTIS **is** the central **source for** the public sale of U.S. Government - sponsored research documentation. Currently the collection incorporates over two million works covering research and development, business and management, translations of foreign reports, trade, general statistics, health and social sciences, and hundreds of other **areas.** It should be noted that NTIS topic coverage is world wide, with **nearly** one-third of new additions to the collection coming from foreign sources[8].

As **a** cornerstone of the technological publishing structure in the United States, NTIS is a key participant in the development of advanced information products and services. In addition to printed reports, **NTIS** makes information available on tape, diskette, and optical disk. Specific services relevant to technology transfer are:[9]

- **Federal Research In Process (FEDRIP)**

  NTIS maintains a data base of Federal Research In Process. This information is made available to the NTTC and several commercial computer modem data access networks including DIALOG and Knowledge Express. Use of this system is suitable to a knowledgeable database researcher who can find needed information quickly, thus keeping on-line expenses reasonable; but use of these commercial services is expensive for an untrained small business to use.

- FEDWORLD

NTIS has recently opened a free computer modem accessible gateway to over 100 Federal Bulletin Boards. This system, known as FEDWORLD, offers access to a wide spectrum of information ranging from environmental policy and hazardous waste disposal to the National Science Foundation's Science and Technology Information[10].

- The Patent Licensing Bulletin Board (PLBB)

The PLBB is an electronic bulletin board system operated by NTIS. The bulletin board provides the earliest possible information about hundreds of new Government R&D inventions available for licensing. The information is supplied by only seven agencies, and noticeably absent from the list are DOD, DOE, and NASA. It is available at no change[11]. Information is searchable in ten major subject categories:

- Biology and Medicine

- Chemistry
- Electro-technology
- Food Technology
- General
- Instruments
- Mechanical Devices and Equipment
- Metallurgy
- Nuclear Technology
- Optics and Lasers

NTIS has established a Memorandum of Understanding with the NTTC to share R&D program and technology information obtained through the NTTC'S interface with Federal R&D Agencies.

While NTIS serves **a very** useful documentation function for the Nation, it cannot be considered as a principal facilitator of technology transfer. NTIS does not provide direct assistance to the public or referrals to federal agencies. As such, while there is **a** wealth of information available at NTIS for purchase, using NTIS has several drawbacks. Secondly, Federal system is slow to make information available to **NTIS,** which then must **be** cataloged and processed; thus the most current technical reports available may be a year or more old. Synopses of research in progress may be so synoptic that the true nature and value of the research can be obscure to the untrained seeker. Finally, the publications made available from NTIS must be purchased to be reviewed or used and may or may not be pertinent to a researcher; this serves as **a** deterrent to access, especially by small business. Many of these problems are inherent because NTIS must rely on other agencies to obtain its information, and the bureaucratic processes are slow. Also due to the fact that it deals primarily with publications, NTIS cannot be considered a rapid access method for finding a technical solution to a problem. Finally, as a side issue relating to Federal agencies interface with the private sector that could result in technology transfer, many government agencies find it more convenient to refer business and industry inquiries to NTIS rather than deal directly with inquiries of a technical nature.

The Federal Laboratory Consortium

A principal Federally-chartered organization critical to technology transfer is the Federal Laboratory Consortium (FLC) which was established by the Stevenson-Wydler Act of 1980, The FLC is a network of technology transfer professionals located principally in the laboratories and R&D Centers whose primary function is to facilitate technology transfer through Offices of Research and Technology

Applications (ORTAs) which are mandated to be at all laboratories with over 200 scientific and engineering personnel.

- **FLC Clearinghouse**

The contracted FLC Administrator in Sequim, Washington operates the FLC Clearinghouse which provides referral services to ORTAs in laboratories which conduct R&D in an area of interest to an inquirer. There is no significant automated information system of technology associated with this effort.

- **FLC Training**

The FLC is also instrumental in providing training to its members and in sponsoring technology transfer demonstration projects. Training focuses on technology transfer management from the perspective of the Laboratory ORTA. Courses are usually conducted at quarterly and annual workshops and involve such subjects as identifying marketable laboratory technology, outreach and marketing, administration, financial management, intellectual property, CRADA establishment and negotiation, and other subjects vital to the function of the ORTAs.

- FLC Publications

The FLC publishes a monthly newsletter - ***NEWSLink,*** and a 220 page document on Federal laboratory technology, expertise, resources and information sources called ***Tapping Federal Technology.***

- FLC Awards Program

The FLC sponsors various awards to recognize outstanding technology transfer managers and organizations for superior achievements in technology transfer. The awards are presented at the annual FLC Symposium.

The National Technology Transfer Center

A major driving force in consolidating information and facilitating technology transfer is the National Technology Transfer Center (NTTC). This organization was established by the Congress in 1989 and funded by a grant through NASA. The Center is based in Wheeling, West Virginia, operates a Washington, D.C. Office and utilizes technology transfer agents throughout the United States. Because of its comprehensive approach and association with most Federal Agencies and Laboratories, it has become a primary organization in National Technology Transfer Activities. This national organization has two key objectives:

- to help American industry gain easy, rapid and productive access to marketable Federal technologies, the most relevant Federal laboratory expertise, and unique Federal laboratory facilities; and

- to help the Federal laboratories find appropriate private partners to develop and commercialize technologies.

The NTTC's mission is to serve as a hub for the national technology transfer network to expedite the movement of Federally developed technology into the stream of commerce. To accomplish this mission, the NTTC has focused its efforts in four areas: technology access (gateway), education and training, economic development and technology transfer services.

- The NTTC Gateway

  The NTTC technology access gateway activity is centered around an evolving Computer Information System (CIS) which is an advanced indexing system for Federal research in progress, laboratory expertise, laboratory technology areas, and unique laboratory facilities. U.S. industry is able to access the NTTC Federal Technology Gateway through an 800 number (1-800-678-NTTC). A highly trained analyst staff works with the gateway user to define the technology requirements (typically through a 10 to 20 minute interview) and then utilizes the CIS to identify potential laboratory contacts for follow-up action. R&D Center and Laboratory ORTAs are then contacted to determine appropriate referrals. Once appropriate linkages are made, the analyst provides the information to the client. On the average, the NTTC spends at least 2 hours on the phone with each client, and several more in researching the problem and following up. The NTTC has established a tracking system to monitor the ensuing interactions between the user and Federal laboratory contacts to assure that the technology transfer process is reinforced by the NTTC. The tracking system provides the NTTC with important data to measure its value added and to adjust its services to meet the demands of both U.S. industry and the Federal laboratories.

  Some examples of technology transfer successes facilitated by the NTTC to date include:

  - a small company in Colorado who accessed technical information from Harvard and Yale research, established a working relationship with a Sandia Laboratory researcher, a business relationship with a

Philadelphia company, and has submitted proposals to both DOE and the Air Force for new instrumentation products.

- A Kentucky company that makes safety switches for coal mines is working with Oak Ridge National Laboratory to incorporate new materials into a new product.

- A packaging firm in West Virginia that found and incorporated a new sealing process from an Army laboratory in New Jersey.

- A Virginia company that was linked to commercial speech-recognition technology and is working to apply it to closed-captioning technology for the hearing-impaired.

The NTTC Federal Technology Gateway system is continuously evolving in terms of capability, content and services. New Federal laboratory databases and technology programs are being added as the program expands. A new bulletin board concept known as "Business Gold" has recently been activated. Business Gold is a spinoff of a technology transfer demonstration between the former Strategic Defense Initiative, the Federal Laboratory Consortium and the Navy. Its primary emphasis is aimed at assisting small businesses. The Business Gold bulletin board is a modem accessible database that provides current SBIR solicitations, Federal technology available for licensing or further development via Cooperative Research and Development Agreements (CRADAs) and listings of state and local sources of business assistance.

It is estimated that the NTTC has obtained the majority (over 85%) of available documented technology and resource information from the major federal laboratories, research centers and agencies (see Appendix C). The Center continuously seeks and adds new data as well as refreshes and updates the data holdings in place.

The purpose of the gateway function is to link Federal laboratories and the national technology transfer network with American companies, trade/professional associations, investors, and economic development organizations. Opened in October 1992, the gateway handled over 3000 referrals in its first six months of operation.

- **Education and Training Programs**

  The goal of the education and training function is to provide familiarization with and training in technology transfer to government, industry and higher education. To accomplish this goal, the NTTC has established a series of initiatives to facilitate the development and delivery of high-quality education and training programs; information and awareness materials; and model programs, standards and networks which enhance technology transfer and innovation management. Specific initiatives include developing training courses, curriculum, and needs assessments; and conducting seminars, conferences, and forums; and providing facilitator/catalysts/instructors to round out complete training and education packages.

  The NTTC education and training activities will help government and industry better understand innovation management and technology transfer and to enhance personal and organizational approaches to these two important concepts,

- Economic Development Programs

  The NTTC economic development program goals are to facilitate linkages between Federal agencies/laboratories and U.S. industry in fostering effective technology transfer management; and assist in regional/state/Iocal technology transfer activities.

  In this area, the NTTC has established several initiatives to begin building bridges to and between public and private organizations.

  The Fund for Strategic Partnering is a program aimed at accelerating the formation of partnerships between Federal laboratories, industry and state/local economic development organizations. The NTTC developed the concept, obtained NASA approval and funding, and issued a solicitation that announced the project and requested proposals from appropriate teams, Over 100 proposals were submitted and in June 1993, the NTTC announced four winners who will share nearly $600K of NTTC funding. The ultimate value of their partnerships exceeds $1 M because of matching commitments by the winning teams, The NTTC will attempt to expand this activity in the future because the quality of the proposals was, in general, outstanding, and the lessons learned in forming cooperative partnerships will have far reaching influence on regional technology transfer initiatives.

Additionally, the NTTC is undertaklng a technology transfer metrics initiative to identify **and quantify measures of effectiveness** and **best technology transfer practices. The Center is working closely with the Interagency Committee on Federal Technology Transfer** chaired **by the** Department of Commerce Technology Administration **to support the committee's Working Group on Measurement** and Evaluation. It is anticipated that this working **group will develop, with NTTC assistance, a system** to **measure the impact of Federal** technology transfer programs on **U.S. industry and** the **economy.**

The NTTC economic development focus will **improve U.S. technology transfer** by recognizing and **disseminating best practices;** initiating strategic partnerships; **addressing regional, state and local technology issues: and stimulating innovation in the technology transfer process.**

- **NTTC Technology Transfer** Services

The NTTC has the capability to provide a broad **range of technology transfer services to Federal** and **industry clients. These services include technology assessment,** market analysis, commercialization reviews, marketing **and outreach** plans, intellectual property **support business planning assessment and** other **relevant activities to transition technology from research** through productization **to** the **market,**

PRIMARY FEDERAL **R&D AGENCY TECHNOLOGY TRANSFER PROGRAMS**

It is important in understanding **the technology transfer programs of** the agencies **to** review **not only their data collection and dissemination activities and information** systems, but also the **other** programmatic details that **foster access to this** data **and the overall mission of technology transfer. Following is** a **description of the programs for technology transfer and commercialization in the primary Federal Agencies,**

The Department of Commerce (DOC)

As the keystone agency for technology transfer **in government, the** DOC has several **programs that** support the management, documentation, access, and **dissemination of technology.**

- **The DOC Technology Administration**

One of the primary responsibilities of the Technology Administration of the Department of Commerce is chairing the Interagency Committee on Technology Transfer. **This committee, comprised of representatives of most of** the Federal **Agencies conducting R&D, is working on three major projects%**

  - **Development of metrics (measures of effectiveness) of technology transfer. These will evolve to a set of parameters** and **methods to document them that can** be used by various agencies to measure their success **in technology transfer and take actions to improve their processes. The NTTC is the facilitator for the development of these metrics.**

  - **Harmonization of CRADA provisions that** can **make it simpler and easier** for industry **to deal with more than one agency in developing CRADAs,**

  - Development **of Conflict of Interest Guidelines that** agencies can refer **to** in developing policy regarding technology transfer programs.

- **The Clearinghouse for State and Local Initiatives on Productivity, Technology, and Innovation**

The "Commerce Clearinghouse" serves as a central repository for information on initiatives **by state and local governments to enhance the competitiveness of American business through the stimulation of productivity, technology and innovation,** The **information provides vital information on contacts for technology transfer driven by thrusts for ● conomlc development. An electronic version is accessible through the NTTC.**

- **The National Institute of Standards and Technology (NIST)**

NIST has recently become one of the primary facilitators of commercial technology development and transfer. The major mission of NIST is to help U.S. Industry improve **the quality and competitiveness of its products. The NIST Advanced Technology Program is** a **primary element in the development of precompetitive technologies critical to America's economic growth. Its technology services enable American industry to access the latest in information on measurements and** standards, and **its many laboratories are advancing the state of the art in numerous**

areas valuable to American industry, offering cooperative R&D opportunities in **such technical fields as Electronics, Physics, Chemical Science, Materials, Computer** Systems, and other **areas** [13].

The Manufacturing Extension Program **(MEP) contains two component programs that are vital to the technology transfer efforts of the Federal Government:**

- **The Manufacturing Technology Centers (MTC) Program - this small program** has **established seven MTCs nationwide to help small and medium sized manufacturers to increase quality and** productivity. **Programs are tailored to the needs of local industry, but each MTC emphasizes technology transfer, helping manufacturers make** effective use of the advanced technology most appropriate for their operations. They also focus on the concepts and practices of **total** quality management,

- **The State Technology Extension Program (STEP) - this program works with state and local technology outreach programs to** improve the competitiveness of small and medium-sized businesses through the application of science **and** technology. Assistance includes: stimulating cooperation and communication between and within states, collecting and distributing information about successful technology assistance activities, and providing matching grants for development and coordination of technology assistance activities.

NIST has established a Memorandum of Understanding with the NTTC to place a liaison person at NIST to facilitate technology transfer program cooperation and effectiveness between the two organizations and with the MTC's.

Patent and Trademark Office

because of the need to protect intellectual property in the technology transfer, patents are an essential part of the process, The Patent and Trademark Office maintains the files of patented technology dating back to the birth of the Nation. heir automated search capability, provided on site, should be considered as an essential element in the documentation of technology and thus the process of Technology transfer, This system requires training and must be used under the supervision **of** Patent Office personnel; it is not **a** modem-accessible system available to the public or to intermediary technology transfer facilitators.

- **The Patent Licensing Bulletin Board (PLBB)**

  An electronic bulletin board system, providing the earliest possible information about the hundreds of new Government R&D **inventions available for licensing is maintained by NTIS. (See above)**

The National Aeronautics and Space Administration (NASA)

NASA has been a **traditional leader in technology transfer since the passage of the Space Act of 1958. As a part of its chartered mission, NASA** makes technology available on a wide-spread basis to American industry through many elements that are part of its Technology Utilization Program. **While not governed by the same** legislation regarding technology transfer as the federal **labs, NASA** endeavors to cooperate **fully with the FLC and** other **Federal** agencies in fostering technology transfer programs and events to promote commercialization of Federal technology [14].

- **NASA Field Center Offices**

NASA has established Field Center Offices at each of its nine major centers and laboratories. **These** offices coordinate and **manage a** full **range** of technology transfer activities including the documentation of new technology developed at the center (which is provided to the **RECON** system - see below), technical assistance, cooperative project development, and outreach to industry,

- Regional Technology Transfer Centers (RITC's)

In close cooperation with the Federal Laboratory Consortium (FLC), NASA has reestablished its network of regional centers in line with the six regions of the FLC. These six not-for-profit centers provide services, on a reimbursable basis, to U.S. firms and industry within their designated regions The RITC's help clients to locate, access, and acquire technologies from throughout NASA and the Federal technology base. RITC's use their internal developed data bases and access many of the others mentioned in this report to find technology, expertise, and resource information. The NTTC is a primary source of information for the RITC's.

- Specialized Technology Transfer Centers

In addition to the six regional **centers,** NASA **supports** several other technology transfer activities:

- **The Technology Applications Team - which works with NASA Field Centers, industry, and national associations to develop cooperative projects and relationships that address technological** needs of a national or industry-wide **significance.**

- **The Computer Software Management and Information Center** (COSMIC) which collects **and documents computer software technology produced by NASA** R&D programs and distributes it to U.S. private, government, and academic organizations.

- **The Earth** Data **Analysis Center (EDAC)** which provides technology transfer assistance and services in support of the distribution and transfer of remote sensing/geographic information systems data to the private sector.

- ***NASA Tech* Briefs**[15]

One of NASA's primary vehicles for technology transfer is its monthly publication *Tech Briefs,* which has a free circulation to over 200,000 qualified government and industry readers, The magazine features information on the full spectrum of NASA developed technology with multi page descriptions of the technology and its applications. Many of these technologies are somewhat limited in their application **(Aerospace Systems)** but some have potential for spinoff to many other applications,

- The NASA RECON **Information System**

NASA maintains an on-line information system cataloging NASA generated technology at its Center for Aerospace Information (CASI) in Baltimore, MD.

NASA RECON is **a** controlled system due to its access to space critical technology. Access by qualified organizations can be arranged through CASI, the principal storehouse of NASA technology information. The Center maintains and distributes NASA technical and program publications and provides general assistance in response to inquiries from the NASA Tech Briefs readership and other U.S. public and private sector organizations,

- NASA Technology Transfer Effectiveness

Early this **year,** NASA announced the results of an internal study of its technology transfer efforts that reported that "there have not been many technology transfer successes compared to the potential.., **and past successes have largely** been

anecdotal." The study also reported that **NASA has been** too slow in transferring knowledge to industry. Technical papers take as long as nine months to be published, and listings in the NASA ***Tech Briefs*** are on the order of eighteen months old. The report also speaks to "cultural" problems in that NASA employees, managers, and contractors "do not feel technology is part of their job" and that "many developers of NASA technology have had little or no direct interest in non-aerospace applications. """ The General Accounting Office, as a result of its review, stated that "NASA does not have an adequate system to comprehensively monitor and measure the applications of the technologies it develops. Without this information, the agency is not in a position to focus its **resources on research** and development activities that can contribute most to preserving the international competitiveness of the U.S. civil aeronautics industry, and cannot determine the impact of its technology transfer activities on the industry's competitiveness ".[17] The report concluded that NASA should intensify its efforts to better identify commercial applications and to find better ways of measuring the impact of its transfer and commercialization.

The Department of Defense

Technology transfer in the DOD is hampered by concerns for mission priority, security, and poor documentation; all are factors in the DOD culture.

Military R&D naturally carries with it **a** major concern for security. This concern is pervasive with regard to technology, creating a perspective that everything developed in the military R&D community is sensitive and not open to disclosure to industry or the public. This unfortunate perspective causes many useful technologies which are part of subsystems and components to be held closely when they could have significant civilian commercial applications without jeopardizing National security.

Department of Defense directives require that all R&D contracts be documented for inclusion in the Defense Technical Information Center (DTIC). The reporting system calls for reporting of project definition information at the beginning of any R&D project, for follow-up reports on progress, and for **a** final report. Unfortunately, these reports are not always made, or if they are, they are very abstract. Federal Acquisition Regulations also provide for "Reports of Inventions" to be made on all federal contracts, Unfortunately, the documentation of these inventions is sparse and the system is not well enforced. The reports are managed through the contracts system and generally wind up in project files without being reported to any central source unless specific arrangements are made. (eg. the NTTC has taken the initiative to obtain electronic Navy patent information directly from the central Navy office that reviews and catalogues the patents). The result is that a

considerable amount of DOD technology remains undocumented. Even with this handicap, the DOD and its laboratories do document a considerable amount of R&D and technology information that has widespread commercial applications.

- **The DOD Office of Technology Transition**

Management of technology transfer activities in the DOD has traditionally resided in the office of the Director, Defense Research and Engineering (DDR&E) under the auspices of the Under Secretary for Acquisition, The FY 93 Defense Authorization Act directed the establishment of an Office of Technology Transition within the Office of the Secretary of Defense (OSD) to be the advocate for technology transfer[18]. This office has been established in name only and has, to date, done little in the area of policy or other activities directed in the Act.

- **The Defense Technical Information Center (DTIC)**

The Defense Technical Information Center (DTIC) focuses on Department of Defense (DOD) contractors and potential contractors. DTIC supplies technical reports of completed DOD R&D efforts as well as summaries of ongoing DOD R&D projects [19,20].

- **The DTIC** Technical Document Collection

As the central DOD scientific and technical information service center, DTIC receives Defense-related reports with classifications ranging from unclassified to Secret and Restricted Data. DTIC's responsibility includes the processing, announcing, storing, and distributing of these reports. DTIC forwards all unclassified/unlimited defense reports (some 60% of all its accessions) to NTIS,

The DTIC technical document collection totals more than a million different titles, covering all areas of science and technology. The main information system for the DTIC collection is the Center's Work Unit Information System which contains the descriptions of ongoing, Defense-sponsored, R&D efforts. The database elements include a narrative description of each effort, its purpose, costs, and the organizations responsible (with names and telephone numbers of key personnel),

- Defense RDT&E On-Line System (DROLS)

DTIC operates the Defense RDT&E On-Line System that is a network of remote terminals connected to the central computer system at the facility in

Alexandria, Virginia. There are over 1,100 remote terminals tied into the on-line system located at Government or contractor sites. Special terminals in Los Angeles, Boston and at DTIC Headquarters provide access to registered user organizations in those areas,

- **Access to DTIC**

Access to DTIC holdings and services is restricted to U.S. government organizations, their contractors and their potential contractors. This automatically restricts non-defense companies from easy access to technology with commercial applications outside those that are military.

Organizations registered with DTIC have access to a variety of products and services. Most of these services are provided free of charge, while very nominal fees are charged for others. The Center provides free searches of the DTIC databases, free referral services, and free work unit information summaries. There is a service charge for paper copies of technical reports,

There are two separate programs through which industrial organizations (from large corporations to small companies) and individual researchers may establish eligibility to receive classified and unclassified data to assist in current research projects. Contractors, subcontractors, and grantees with current U.S. Government contracts or grants may obtain access by filing the necessary registration forms. These forms are reviewed by their Government sponsors prior to approval by DTIC. Potential defense contractors with adequate research and development capabilities can also gain access to DOD R&D planning, requirements, contacts in laboratories and other DOD R&D activities, and other scientific and technical information on DTIC databases. DTIC performs the central registration function for the DOD organizations sponsoring the program, but each of the military departments and the Advanced Research Projects Agency (ARPA) executes its own policy agreements with industrial participants. Registration for this program qualifies participants for access to the scientific and technical data bank at DTIC,

To enhance access to DTIC information, NTTC analysts have access to DTIC resources in order to identify DOD expertise and resources as well as information on unclassified R&D and technology.

- **The Ballistic** Missile **Defense Organization (formerly Strategic Defense Initiative) Technology Applications Program**

Recognized by Congress as a premier technology transfer program, this dynamic technology transfer activity was recognized in the FY 93 Defense Authorization Act as the model program for the establishment of a DOD Technology Transition Office. The program, established in 1986, conducts **a** full range of technology transfer activities and pioneered several new approaches to technology transfer which have produced significant results to date, including the establishment of 22 Spinoff Companies, generation of 97 new products on the market, filing of 97 patents, and establishment of 8 CRADAs[21].

- **Technology Application Reviews**

The Technology Applications Program conducts technology applications reviews each focusing on a different technology area such as biomedical, optics, materials, electronics or power. These meetings are usually held at Federal R&D facilities, bringing together public and private experts to hear the results of the R&D from the actual scientists and engineers involved, and to work hand in hand with these specialists to develop application targets and commercialization strategies. Subjects addressed include intellectual property, business planning, project and company financing, strategic partnering, market requirements, market analysis, competition, and alternative strategies. After each review, the program follows through on promising technologies and provides tailored support to foster spinoffs that will benefit the nation's economy. The reviews also provide access to information on technology that is captured in the program's data base, the Technology Applications Information System.

- The Technology Applications Information System (TAIS)

The Technology Applications Information System contains over 2,000 abstracts of SDI/BMDO-funded technologies The program is continuously updating and expanding these abstracts to include new developments in BMDO research. A TAIS user can make an on-line request for more information on any technology abstract and the program staff will link the user to the researchers involved with the technology, whether the technology has been developed in a Federal laboratory, university or business. The program staff follows up with the user to assure that his/her needs are met and to track successful linkages between the technology and potential market applications. The TAIS is open to any American business

or Individual who registers with the Defense Logistics Agency in a process that involves a simple form and about two weeks processing time. Over *20,000* companies and individuals are registered under this system. One of the unique features of the TAIS is its ability to document users and follow up on results. This capability has enabled the program to measure its success over the past seven years.

- **Proactive Outreach Program**

The BMDO Technology Applications Program, supported by the NTTC, produces several Technology transfer publications such as the ***BMD High Technology Update, a*** quarterly newsletter provided to over 6,000 recipients free-of-charge, and the ***BMD Technology Applications*** Report[22], an annual summary that describes SDI/BMDO'S technology transfer program and highlights representative spinoff successes. Additionally, the NTTC provides focused articles on specific technology innovations or successful commercialization activities by researcher for publication in a broad range of media such as newspapers, magazines and technical/Wsiness journals.

The BMDO Technology Applications Program interfaces with professional and trade associations; Federal, state and local government organizations; universities; businesses: and other entities that share the organization's goal of improving America's economic well-being by introducing new technology into the marketplace.

The organization also promotes the commercialization of technology through technology transfer demonstration projects, working with small high-tech businesses, state organizations, and the Federal Laboratory Consortium,

- **Advanced Research Projects Agency (ARPA)**

ARPA has traditionally been recognized as a principal driver in generating technology that has commercial benefits, yet ARPA has no structured Technology Transfer Program per se. The ARPA approach maintains that technology transfer to industry is an integral part of every R&D effort that it sponsors and takes no additional effort to be proactive in commercialization of technology outside of the direct program sponsorship it provides.

ARPA defense R&D is focused across the spectrum of defense needs, and resident in four major programs dealing with simulation, software, materials and manufacturing, and space technology.

- **Technology Transfer in the Military** Services

  The Military Services principally focus on activities within their own laboratories as the resource base for technology transfer. They do not normally consider the R&D sponsored outside of the laboratories (eg in corporations, universities, or via SBIR **Programs) as a resource for** technology transfer. The management structure is resident at the level of the Secretary of the Army and Air Force, and at the Office of Naval Technology for the Navy. These functions are strictly policy oriented and not well supported in terms of resources or personnel by any of the services.

  A number of Defense Laboratories and R&D Centers have proactive programs in technology transfer. They have Offices of Research and Technology Applications (ORTAs), as mandated under **legislation,** which attempt to create awareness and provide access to technology and expertise resident in their individual laboratories. For the most part, these offices tend to be understaffed and must operate with budgets insufficient to the task of identifying and marketing the technology developed by their organizations. The ORTAs coordinate closely with the Federal Laboratory Consortium, and the National Technology Transfer Center. Both of organizations facilitate access by business and industry through the ORTAs.

- The Corps of Engineers Construction Productivity Advancement Research (CPAR) **Program**

  CPAR is a program of cost-shared research, development and commercialization/technology transfer (R&D) projects between the U.S. Army Corps of Engineers and the U.S. construction industry [23]. The purpose of the program is to assist the U.S. construction industry in enhancing its productivity and domestic and international competitive position through the development and commercialization of advanced technologies, materials and construction management systems. Information on CPAR-sponsored technology is available through the NTTC.

The Department of Energy (DOE)

As one of the three principal R&D agencies, DOE has a diverse spectrum of programs that facilitate technology transfer. The agency is home to nearly 60,000 scientists, engineers, and technicians who perform about $6.6 billion worth of R&D each year. The agency has R&G responsibilities that include developing technology that produces or conserves energy, developing environmental restoration and waste minimization technology, and developing and protecting

nuclear energy technology for both civilian and defense applications. These R&D missions represent a challenge **for** technology transfer when **the** technologies are associated with nuclear programs and **an** embedded technology transfer responsibility for energy efficiency **and environmental technologies[24].**

- **The Office of Scientific and Technical Information (OSTI)**

The principal repository for R&D and technology information for the DOE is placed with The Office of Scientific and Technical Information (OSTI) located in Oak Ridge, TN. This organization catalogues and provides access to DOE-generated technology through its own controlled systems. OSTI maintains and periodically publishes a list of DOE-funded technologies entitled ***DOE New Technology.*** OSTI also catalogues computer software through Its Energy Science and Technology Software Center.OSTI's method for providing public access is by providing information and announcements to NTIS and the Government Printing Office.

OSTI Data Bases include:

- Energy Science and Technology - Bibliographic records of worldwide information related to energy and nuclear science and technology, This database is also available on DIALOG.

- Energy Science and Technology Software - Bibliographic records that describe scientific and technical software. This database is also available on DIALOG.

- New Technology from DOE - Brief descriptions of DOE research results that have potential for commercialization efforts.

- Research in Progress - Descriptions of current or recently completed research projects conducted or funded by DOE. This information is provided to NTIS and is made part of the FEDRIP information system.

Information on DOE R&D programs, technology, expertise and resources are made available to the NTTC under a Memorandum of Agreement between NASA and DOE established in July 1992.

- **DOE Technology Transfer Programs**

DOE **employs a full range of mechanisms to transfer technology. These** methods are explained in detail **In the section of this report titled** "Mechanisms for Technology Transfer", **and include:**

- Cooperative Agreements
- Cooperative Research and Development Agreements (CRADAs)
- **R&D Consortia**
- **Exchange Programs**
- **Patent Licensing Agreements**
- User Facility Agreements
- Work-for-Others

- Special DOE **Technology Transfer Programs**

In addition to its SBIR program, the **DOE sponsors** two unique programs that provide for the development of inventions and innovations by individual inventors that foster energy efficiency and conservation, supporting DOE's R&D efforts as well as contributing to DOE's technology transfer efforts outside the laboratories.

- **The Energy-Related Inventions Program**[25]

The Energy-Related Inventions Program (ERIP) is **a** joint program of the Department of Energy (DOE) and the Department of Commerce (DOC). The program provides for a free evaluation of energy-producing and energy conservation-related concepts, devices, products, materials or processes. The invention may be in any stage of the development process ranging from novel concept to product ready for market. Evacuations are conducted by the National Institute of Standards and Technology (NIST). There is no fee or obligation for obtaining an evacuation from NIST. If an invention is recommended by NIST to DOE for funding and accepted, grants of up to just under $ 100,000 may be provided for development of selected inventions. Since 1975, some 30,000 inventions and ideas have been evaluated, 591 were recommended, and about 80% of these have been funded.

The Energy-Related Inventions Program also provides two training courses throughout the country, with workshops for inventors that can assist them with the commercialization and marketing of their new products and technologies.

- The **Innovative Concepts Program**[26]

The Innovative Concepts (lnnCon) program, sponsored by the Department of Energy, **provides seed-money** grants to encourage energy innovation and helps new technologies move quickly **from the concept stage into** the **marketplace. InnCon is a bridge between program managers in** government **and industry and creative** people **and technologists with new** ideas for solving **applied energy and environmental problems.** InnCon normally specifies the **topic areas of interest. For the past two years, the specific research topic area sponsored has been Waste** Minimization/Utilization. The seed funding is intended to further develop **the** concept to a stage at which other prospective sponsors **can more clearly assess the** concept's potential. After completion of the grant, the funded technologies and federally-supported technologies are **showcased at a technology and** business opportunity fair, held specifically to expose potential sponsors to the new concepts. **For some of these technologies, the fair is their first** public introduction, The InnCon Program provides grants of up to $20,000 **for** up to 15 inventions and technologies each **year that meet the advertised** criteria. Projects are selected under **a** competitive process.

Department of Health and Human Services (HHS)

The principal R&D organization within HHS is the National Institutes of Health (NIH) Most of the department's technology transfer activities, including that of the Public Health Service (PHS), the NIH, the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA), and the Center for Disease Control (CDC) are managed through the NIH Office of Technology Transfer[27].

- PHS Office **of Technology Transfer On-Line** (PHS-OTTO)

The PHS-OTTO is an electronic bulletin board that contains a variety of **essential technology transfer data,** This service contains downloadable copies of PHS technology transfer guidelines and model agreements, **a** list of current CRADAs and PHS Scientists interested in new CRADAs, as well as summaries of inventions available for licensing, It is updated periodically **during the year** and is also made available to the NTTC,

- **Computer Retrieval of Information on Scientific** Projects (CRISP)

CRISP is **a** major scientific information system containing data on the research program sponsored by the Public Health Service. Most of this research falls **within** the broad category of extramural projects: grants, contracts and cooperative

agreements. PHS and other Federal agencies can establish an account to access CRISP. The information is also made available to the NTTC and DIALOG.

The U.S. Department of Agriculture (USDA)

As one of the oldest institutions conducting technology transfer, the USDA Agricultural Extension Service is known as the grandfather of all technology transfer programs. USDA, through the Agricultural Research Service (ARS) generates a significant number of inventions and technology that have wide-spread applications.

- **TEKTRAN - The USDA Technology Transfer Information System**

USDA developed the TEKTRAN system to document agricultural technology and make it accessible via modem to potential **users. Over 12,000** summaries of the latest research results on genetic engineering, safeguarding crops and animals from diseases, biological control of pests, human nutrition, and other fields are available. The service is provided at no cost[28].

- The Alternative Agricultural Research and Commercialization Center (AARC)

The purpose of the AARC is to facilitate and accelerate development and commercialization of industrial (non-food, non-feed) products manufactured from farm and forestry materials. Information on technology developed by the program will be provided to the NTTC for dissemination[29].

- **The Agricultural Inventions Catalog[30]**

USDA publishes a 150 page catalog containing abstracts of thousands of patented inventions developed under USDA sponsorship. This catalog is available on-line through the NTTC.

The Department of Education

The principal technology development activity within the DOEd is that conducted by the National Institute on Disability and Rehabilitation Research (NIDRR). This organization manages a number of activities important to technology transfer[31].

- **Rehabilitation Research and Training Centers (RRTCs) -** each center focuses on a particular aspect of behavioral, medical, or vocational rehabilitation. Knowledge contributed by these centers has greatly influenced the fields of

rehabilitation medicine, psychological rehabilitation, integration, vocational strategies, and architecture.

- **Rehabilitation Engineering Centers (RECs) -** these organizations seek solutions to disability-related problems through technology. Areas of study **include sensory loss, mobility impairment, chronic pain, and** communication difficulties.

- **The Rehabilitation Information System (RIS) -** contains information on R&D activities. It is made available via computer modem to rehabilitation professionals, researchers, and people with disabilities to locate technology and information.

The Environmental Protection Agency (EPA)

The EPA is principality a regulatory agency, thus much of its R&D activities are oriented toward enforcement technologies. The agency does produce technology with commercial applications, has a proactive technology transfer program and maintains several data bases of interest[32]:

- **The Alternative Treatment Technology Information Center (ATTIC)**

  ATTIC is a comprehensive, automated information retrieval system that integrates technical hazardous waste information into a centralized, searchable resource. ATTIC provides data and technical information on methods of hazardous waste treatment and is accessible to all members of the Federal, State, and private sector involved in site remediation. The service is provided free[33].

- **The Pollution Prevention Information Clearinghouse (PPIC)**

  PPIC is a clearinghouse dedicated to reducing industrial pollutants through technology transfer, education, and awareness. The system contains technical, policy, programmatic, legislative, and financial information. **The** service is provided free[34].

- **The Vendor Information System for Innovative Treatment Technologies** (VISITT)

  VISITT is a compilation of technical information and products provided by hundreds of pollution treatment vendors. The VISITT data base can also be accessed through the NTTC.

The Department of Transportation (DOT)

The principal technology developers within DOT are the Federal Aviation Administration (FAA), and the Federal Highway Administration (FHWA).

The FAA manages its technology transfer program principally through the FAA technical Center ORTA in Atlantic City, NJ. Principal R&D programs and points of contact are contained in the FAA Plan for Research, Engineering and Development[35] which is provided to the NTTC for electronic access.

The FHWA operates an extensive technology transfer network with Local Technical Assistance Program (LTAP) offices in each state. The FHWA promotes technology transfer thorough demonstration projects, Applications Projects, Test and Evaluation Projects, and Special projects for evaluation[36]. Technical abstracts of these R&D projects, locations of the centers, training and technology resources, and the Nationally Coordinated Plan of Highway Research, Development, and Technology[37] are electronically accessible through the NTTC.

Other Federal Agencies

Other federal agencies that conduct Research and Development operate their technology transfer programs principally through their laboratories and the FLC. The individual laboratories are asked to provide electronic media information to the National Technology Transfer Center which provides a gateway service for the ORTAs at each laboratory.

The Critical Technologies Institute (CTI)

The Critical Technologies Institute is an organization of the White House Office of Science and Technology Policy. It was created by Congress in 1991 as a Federally Funded R&D Center (FFRDC) and is operated by the RAND Corporation. CTI provides analytical support to the Executive Office of the President[38].

- **The CTI Data Base System**

CTI is conducting a top-down, fiscal-based survey of all Federal R&D Programs. The information is derived from:

- **The Federal Procurement Data System - managed by General Services** Administration (GSA), containing information on all contracts awarded by the Federal Government.

- The Federal Assistance Awards Data System - managed by DOC contains information on all grants and assistance programs to states, institutions, etc.

- **The Budget Preparation System - essentially** the Federal Budget Data Base - managed by the Office of Management and Budget.

- **The Catalogue of Federal Program Assistance -** managed by GSA containing programmatic information on federal programs.

- **The Consolidated Federal Funds Report -** managed by the Census Bureau of DOC.

CTI works **closely** with the NTTC and other agencies to share data and resources. The CTI data base contains classified information and is used only for internal management and studies. It is not open for access by the public.

PRIVATE SECTOR PROGRAMS

A number of private sector programs provide technology transfer information services for a fee. These programs operate in parallel and sometimes in cooperation with other organizations to obtain and disseminate information.

- **Teltech™**

  Teltech, based in Minneapolis, MN, is a commercial technical service that provides access to both knowledgeable individuals as well as an information retrieval service. The service advertises that it provides fast, accurate answers to technical questions[39], The service operates through telephonic contact with a network of Teltech experts selected form universities, national laboratories, consulting groups, and industry retirees. Charges for these services are approximately $165 per inquiry. Teltech provides technology research services and literature searches through other information resources such as the numerous ones listed above; an inquiry can be made on line with the searcher, and the charges for this service run from $165 to $200 per hour. It is suitable to a much more in-depth, hand-in-hand technology transfer approach with a tailored response to business, market analysis and technical questions.

- **Knowledge Express™**

Knowledge Express is an on-line modem-access commercial information service designed to find and evaluate R&D opportunities from U.S. Government laboratories, universities, research institutions, and companies. Its holdings include information from PHS, ARS/USDA, DOE, NITS, MIT, The University of California, Columbia University, Cornell, and Harvard[40]. The service is available for an initial fee of $250 annually renewable at $100 with access fees of $2 per minute. Reports cost an additional $1.25 to $9.25 depending on the information system searched,

- **Technology Access Report"**

Technology Access Report is principally a newsletter **publication on** technology transfer; however, it maintains a Technology Access Hotline that provides technology transfer services to subscribers, An annual subscription is $447.

- **Technical Insights, Inc.'***

Technical Insights, Inc. provides several technology transfer and commercialization information services to business and industry. These include *Inside* ***R&D,*** a weekly publication on current R&D with a special section devoted to technology transfer; and monthly publications on ***Advanced Manufacturing Technology, Industrial Bioprocessing,*** Genetic Technology News, Futuretech Strategic Markets, Sensor Technology, Advanced Coatings and Surface Technology, and High Tech Materials Alert. Subscriptions to each of these publications average from $485 to $1,500 per year.

- **Pennsylvania Business Information Center On Line**

Sponsored by the Philadelphia-based Ben Franklin Technology Center of Southwestern Pennsylvania, the Business Information Center has recently opened an on-line data base aimed at small and medium-sized businesses which is partially funded by Bell Atlantic corporation[43],

- **Texas** Innovation Network

The Dallas-based Texas Innovation Network (TIN) claims to be the most comprehensive state-funded technology information service in the U.S. The system is available **via *Internet* at a rate of 35** cents per minute".

- Best **North America's**

This service, provided by Cartermill, Inc. is targeted toward large corporations. The service provides information on research at more than 300 academic research institutions in North America, Britain, and Western Europe. An annual subscription costs $2,500 plus $300 **per hour** for on-line searches. Unlimited searching is provided with an annual $10,000 fee. Custom searches are also available.

- **Technology Transfer Search System**[46]

Illinois-based Technology Search, International, Inc. provides a publication "Finding and Licensing New Products and Technology" and is introducing a new Technology Transfer Search System Database.

Top 10 Universities in Licensing Income FY 89-90

1. **Stanford $24.8M**
2. **Wisconsin $21.9M**
3. **Michigan State . . $12.1 M**
4. **Columbia $12.5M**
5. **UC-San Francisco $11.3M**
6. **MIT . . . . . $ 5.2M**
7. **Colorado . . . . . $ 3.7M**
8. **U. Washington . . $ 3.0M**
9. **Harvard . . . . . $ 2.5M**
10. **Minnesota . . . . . $ 2 . 3 M**

Figure 1

PROMINENT UNIVERSITY PROGRAMS

Federally-sponsored research at universities has taken an downturn, but some of the major universities have found **a** new source of revenue in the licensing **of** their technology, both university sponsored and federally-sponsored (Fig. 1) and significant numbers of patented technology are emerging as a result (Fig 2)[47,48], The potential for conflict of interest and the requirements to document federal work are two complicating factors in university technology transfer management activities. Two programs will serve to illustrate the types of activities at these institutions:

- **The MIT Licensing Office**

The Massachusetts Institute of Technology (MIT) has a prime interest in taking equity in a business start-up, but closely regulates the propriety of such an equity position, both from the viewpoint of the university and the researchers who developed the technology. MIT has helped develop more than 30 spin-off companies in the last five years. The university still has to distinguish carefully which technologies have received Federal sponsorship (such as that emanating from Lincoln Laboratory) as opposed to those that have been strictly University sponsored. Federally sponsored research is required to be reported and is collected by the NTIS. For these types of technologies, the Government has royalty-free use, while the University can take steps to commercialize the technology. The technology licensing office maintains information on all viable technology and its patent status, and responds to inquiries from industry and potential investors.

- **Johns Hopkins University Programs**

At Johns Hopkins, the Federally sponsored technology at the Applied Physics Laboratory (APL) is managed separately from other University research. The APL Technology Transfer Office is currently working with the NIT-C to provide a gateway to information on the technologies produced with Federal funding from DOD and NASA.

Across the campus, another activity involves an initiative oriented toward commercializing university spinoffs. The Triad Investors Corporation is seeking out and cataloging technology with commercial applications that can be developed for less than $200,000 in less than 18 months. One company that has recently spun-off from Hopkin's research is marketing a CPR vest which provides artificial pulmonary resustication for heart attack patients. For those familiar with the technology commercialization process, this objective is an ambitious one. The university is setting up collaborative agreements such as a recent partnership to fund cancer research where the participating company gets an options on new treatments or diagnosis technology.

Top TECHNOLOGY Universities in Invention Disclosures FY 89-90	
1. MIT	609
2. Stanford	311
3. Minnesota	309
4. Wisconsin	225
5. Cornell	181
6. Harvard	165
7. Michigan	162
8. U. Washington	148
9. Johns Hopkins	141

Figure 2

MOVING TO A MORE COMPREHENSIVE, USER-FRIENDLY SYSTEM

Considering the diversity and complexity of the process, the resources, and the challenges, technology transfer successes do occur. There are many aspects to be addressed in the consideration of developing a more comprehensive, user-friendly information system for technology transfer.

Technical Education and Skills - It is a major tenant of successful technology transfer that the process must be conducted in a person-to-person mode. Knowledge transfers through personal interaction, thus the creation of data bases of technology information should be considered a viable tool for the process, but there are many other aspects required for success. Principal among these is the involvement of an individual with a technical background in the area of interest and someone knowledgeable of the federal system and the means to search available information systems.

Knowledgeable - The availability of information is not as universally known as it should be. Continued outreach and marketing efforts are needed to make business and industry knowledgeable of resources for technology transfer access.

User-Friendliness - Electronic access to information in the technology transfer process is wide-spread and of varying utility. Many of the systems mentioned in this report are difficult for the average person to use. Some do **not have search** capabilities and require paging through lists of information to find something potentially applicable. Effective systems offer a search capability that extends across all data at a time and permits boolian[1] search methods

Currency of information - Some systems are updated continuously, while others are changed only on an annual basis, Updating of large systems is a labor-intensive process. Consolidated systems must reply on the originating agencies to keep information current and maintain constant liaison to ensure the most recent information is available.

Need for Facilitators - The role of intermediaries (RITCs, MTCs, SBDCs, and extension services) in the technology transfer process is vital in reaching small and medium size businesses. These intermediaries can be most effective when they have technical staff members who understand technology and applications as well

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.boolian searching allows for the selection of several terms to search for at one time and other options to limit the search to obtain the desired results.

as know how to search efficiently for information. Unfortunately, most SBDC's do not have this kind of staff, nor are many able to afford the expertise. Their linkages with universities are mostly from the business aspect and not enough from the technical aspect. These intermediaries need to be educated in understanding the technology transfer and commercialization process as well as trained in skills such as effective information search and retrieval.

Formats for cataloging technology for the purposes of technology transfer have been developed by most of the agencies conducting R&D, While they are all somewhat different, they cover the major elements of describing the technology in abstract form, provision for keywords, and discussion of applications. For the most part, these forms capture the essential elements of the technology. Regarding the creation of a standardized form or format, this may assist in the process if it could be developed in cooperation with all R&D agencies and implemented across all Federal agencies. Formats and taxonomies for cataloging technology have essentially become of questionable utility now that rapid search software can access and identify information sought from millions of records in a few seconds time. The appropriate organization to address this issue is the Interagency Committee on Technology Transfer chaired by the DOC Technology Administration.

A comprehensive resource for use by intermediaries is also essential; however, the creation of a master data base of all technology accessible by all people is a goal which most likely cannot be achieved due to the basic facts involving security and proprietary rights. These two considerations will always stand in the way of complete public access to technical information.

Cost is a major consideration for small businesses who cannot afford the expensive rates of commercial technology access services.

There will always be conflicts between services provided by the government and those offered by the private sector. The difference between the two will most likely be the amount of value added in terms of tailored, personal interactive services for individual companies. These services will be the determining factor in the willingness of business and industry to pay for services.

Taking a Holistic View

The objectives for improving the process of technology transfer on the part of the Federal Government should take a holistic view of the problem, and not focus on just the creation of a sophisticated access system.

Continued Congressional support of the existing grass roots infrastructure of small business development centers, the Regional Technology Transfer Centers, Manufacturing Technology Centers, and other technology extension activities is essential to the picture.

To enhance the effectiveness of the intermediaries, Education and Training courses in technology transfer and commercialization should be developed specifically for the intermediary organizations and provided under the auspices of a national organization with the appropriate expertise.

Also in taking a holistic approach, Government leadership should envision an organization that is chartered and adequately funded to address the majority of the issues of technology transfer by:

- Assembling a resident staff of experienced technology transfer professionals
- Establishing a network of technology transfer specialists across the Nation to assist in outreach and technology transfer activities.
- Developing a proactive national outreach program.
- Establish cooperative working agreements with Federal agencies, laboratories, and universities conducting federal research to acquire information and provide outreach and access services.
- Creating a national information system on Federal R&D programs, technology, resources, and sources of assistance.
- Providing a gateway service with both direct computer access and experienced technology analysts to assist in locating appropriate technology, expertise, and/or resources in the Federal system,
- Developing educational and training courses for technology transfer professionals and intermediary organizations to help them address the many-faceted challenges of technology transfer.
- Sponsor and fund special cooperative programs to ferret out and commercialize viable Federal technologies.
- Investigate methods of measuring success in technology transfer activities and developing recommendations for better tools and techniques.
- Conduct special studies to assist in the formulation of legislation, policy and programs dealing with technology transfer.

Current Assessment

Considering all of the organizations involved in technology transfer, the cross-cutting organizations who have the most expertise and influence on the process

are the Federal Laboratory Consortium, the National Technology Transfer Center, and the National Institute of Standards and Technology.

Intermediary technology transfer facilitators (SBDCs, MTCs **and State** extension activities can play a vital role in the technology transfer process, but they need more training in the technology transfer and commercialization process and in specific skills and techniques to be effective.

Considering all of the organizations and activities ongoing to facilitate technology transfer of Federally-developed technology, the NTTC appears as the best postured **to lead in the development of programs methods and** metrics and in becoming the central fast-access point for new technology for American small and medium sized businesses,

Opportunities

Considering all of the aspects of, challenges, and participants in technology transfer, the most sensible opportunities for enhancing the current practice is to continue and perhaps increase support to the NTTC, and to provide training and other assistance to the other intermediary organizations (SBDCs, RTTCs, MTCs) as facilitators to small and medium size **business and industry.**

The current Federal sponsorship of the NTTC expires in FY 95. Consideration should be given to either additional funding, or to establishing the center as a Federally Funded Research and Development Center with provisions for annual federal funding support. Sponsorship of the Center might also be more appropriately placed with the Department of Commerce rather than NASA.

Most legislation regarding Federal technology transfer is focused on transfer of technology from the laboratories only[49]. Because only about half of the Federal R&D expenditure is in the laboratories, consideration should be given to emphasizing Federally-sponsored technology from other sources as well.

Any new innovations in facilitating federal technology transfer should be reviewed by the Interagency Committee on Technology Transfer chaired by the DOC Technology Administration and considered for implementation by the NTTC.

Appendix A
A SUMMARY OF
PROMINENT FEDERAL DATA BASES AND ON-LINE SYSTEMS FOR TECHNOLOGY TRANSFER

- FEDWORLD - access to over 200 federal bulletin boards and information systems. Managed by the National Technical Information Service **(NTIS). To access, modem 703-321-8020. Set modem to (N-8-1) (Parity NONE, Data Bits to 8, Stop Bits to 1), Emulation VT 100 or ANSI. Accommodates up to 9600 baud.**

- BUSINESS **GOLD - access to the National Technology Transfer Center information on new technology, programs, and resources from ail Federal Research and Development agencies. Modem 304-243-2561. Set modem to (E-7-1), emulation VT 100. Accommodates up to 9600 baud.**

- **The Patent** Licensing Bulletin Board (PLBB) - an electronic bulletin board system operated by **NTIS. The bulletin board provides the earliest possible information about the hundreds of new Government R&D inventions available for licensing. Information on patents is provided by seven federal agencies. It is available at no charge. Modem 703-487-4061. (N-8-1), emulation VT 100.2400 Baud (The system is also available on FEDWORLD)**

- **FEDIX -** Federal Information Exchange - data on programs, points of contacts, publications, and available lab equipment from the Federal Aviation Administration, Department Of Energy, Air **Force Office of Scientific Research, Office of Naval Research, and NASA. Modem 800-783-3349 (N-8-1), emulation VT 100.2400 Baud.**

- **Small Business Administration On-Line - Modem 800-859-4636 (E-8-1) VT100, 2400 baud.**

- **U.S. Department of Agriculture TEKTRAN - Access to over 12,000 research results in agricultural research. For access registration and information, call 301-504-5345.**

- **Pollution Prevention Information Clearinghouse - an information system dedicated to reducing industrial pollution through technology transfer, education, and public awareness. Sponsored by EPA or information call 202-475-7161.**

- **Library of Congress - access to wide spectrum of information and programs. Modem 202-702-4888 (N-8-1) VT1OO, 2400 baud.**

- **SDI Technology Applications Information System - Technology from the Strategic Defense Initiative (SDI) program (now known as the Ballistic Missile Defense Program). over 2000 abstracts of leading edge technology available to any American citizen or company. Contact 703-693-1563 for details on access requirements. Modem 703-693-3007**

- **Defense RDT&E On-Line System (DROLS) - a network of remote terminals connected to the central computer system at the DTIC facility in Alexandria, Virginia. There are over 1,100 remote terminals tied into the on-line system located at Government or contractor sites.**

Special terminals in Los Angeles, California; Boston, Massachusetts; and at DTIC Headquarters provide access to registered user organizations in those areas. Access through certification by DTIC.

- The Clearinghouse for State and Local Initiatives on Productivity, Technology, and Innovation The "Commerce Clearinghouse" serves as a central repository for information on initiatives by state and local governments to enhance the competitiveness of American business through the stimulation of productivity, technology and innovation. The clearinghouse is maintained and updated by the Technology Administration. An electronic version is accessible through the NTTC. (See Business Gold above).

- Federal Research In Process (FEDRIP) - A data base of Federal Research In Process maintained by NTIS. This information is made available to the NTTC and several commercial computer modem data access networks including DIALOG and Knowledge Express. Use of this system is suitable to a knowledgeable database researcher, but the cost is prohibitive for an untrained small business to use.

- The NASA RECON Information System - an on-line information system cataloging NASA generated technology at its Center for Aerospace Information (CASI) in Baltimore, MD. NASA RECON is a controlled access system due to its access to space critical technology. Access by qualified organizations can be arranged through CASI, the principal storehouse of NASA technology information.

- PHS Office of Technology Transfer On-Line (PHS-OTTO) - an electronic bulletin board that contains a variety of essential technology transfer data. This service contains downloadable copies of PHS technology transfer guidelines and model agreements, a list of current CRADAs and PHS Scientists interested in new CRADAs, as well as summaries of inventions available for licensing. It is updated periodically during the year and is also made available to the NTTC.

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- TEKTRAN - The USDA Technology Transfer Information System - a database of agricultural technology accessible via modem to potential users. Over 12,000 summaries of the latest research results on genetic engineering, safeguarding crops and animals from diseases, biological control of pests, human nutrition, and other fields are available. The service is provided at no cost. Information on TEKTRAN available from USDA Agricultural Research Center (301) 504-5345

- The Alternative Treatment Technology Information Center (ATTIC) - a comprehensive, automated information retrieval system that integrates hazardous waste data into a centralized, searchable resource. ATTIC provides data and technical information on methods of hazardous waste treatment and is accessible to all members of the Federal,

State, and private sector involved in site remediation. The service is provided free. For information call (301) 816-9153. Access to ATTIC is also available.

The Pollution Prevention Information Clearinghouse (PPIC) - a clearinghouse dedicated to reducing industrial pollutants through technology transfer, education, and awareness. The system contains technical, policy, programmatic, legislative, and financial information. The service is provided free. Access to PPIC is also available through the NTTC (see Business Gold).

- **The Vendor Information System for Innovative Treatment Technologies (VISITT) - a compilation of technical information and products provided by hundreds of pollution treatment vendors. The VISITT data base can also be accessed through the NTTC. Access to VISITT is also available through the NTTC (see Business Gold).**

Appendix B

FEDERAL INFORMATION RESOURCES AVAILABLE THROUGH THE NATIONAL TECHNOLOGY TRANSFER CENTER

NTTC DATA RESOURCES BY AGENCY

Department of Agriculture

- **SBIR Program Abstracts and Topics****
- **USDA Inventions Catalog***
- **Tektran** Data Base of **USDA R&D***
- **USDA Patent Information***
- **Catalog of Federal Domestic Assistance**

Beltsville Agricultural Research Center

- **ARS Technology**

Eastern Regional Research Center

- **"Organization and Functions of the Eastern Regional Research Center"**
- **"History of the Eastern Regional Research Center**
- **"Laundry List of Projects from Eastern Regional Research Center"**

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Appendix C

THE INNOVATION PROCESS[45]

GLOSSARY

A A R C	Alternative Agricultural Research Commercialization Center
A D A M H A	Alcohol, Drug Abuse, and Mental Health Administration (HHS)
AFT ²E	Association of Federal Technology Transfer Executives
ARPA	Advanced Research Projects Agency (DOD)
ARS	Agricultural Research Service (USDA)
B M D O	Ballistic Missile Defense Organization (DOD)
CASI	Center for Aerospace Information (NASA)
CDC	Center for Disease Control (HHS)
CPAR	Construction Productiviy Advancement Program (DOD)
CRADA	Cooperative Research and Development Agreement
CRDA	Cooperative Research and Development Agreement
CTI.	Critical Technologies Institute
DDR&E	Director, Defense Research and Engineering
DOD	Department of Defense
DOC.	Department of Commerce
DOE	Department of Energy
DOEd	Department of Education
DOT	Department of Transportation
DROLS	Defense Research On Line System
DTIC	Defense Technical Information Center (DOD)
EADC	Earth Data Analysis Center (NASA)
ERIP	Energy Related Inventions Program (DOE)
FAA	Federal Aviation Administration (DOT)
FEDRIP	Federal Research In Progress
FFRDC	Federally Funded Research and Development Center
FHWA	Federal Highway Administration (DOT)
FLC	Federal Laboratory Consortium
FRA	Federal Railroad Administration
FTTA	Federal Technology Transfer Act (of 1986)
FY	Fiscal Year
GAO	General Accounting Office
HHS	Department of Health and Human Services
Inn Con	Innovative Concepts Program (DOE)
LTAP	Local Technology Assistance Program (DOT-FHWA)
MEP	Manufacturing Extension Program (DOC-NIST)
MC	Manufacturing Technology Center
NASA	National Aeronautics and Space Administration
NIDRR	National Institute for Disability and Rehabilitation Research (DO EC)
NH	National Institutes of Health
	Not Invented Here
NIST	National Institute for Standards and Technology (Formerly National Bureau of Standards)
NITS	National Technical Information Service (DOC)
NTTC	National Technology Transfer Center
ORTH	Office of Research and Technology Applications
OSD	Office of the Secretary of Defense

OSTI	**Office of Scientific and Technical information (DOE)**
PHS	**Public Health Service**
PPIC	**Pollution Prevention Information Clearinghouse (EPA)**
R&D	**Research and Development**
RDT&E . . .	**Research, Development, Test and Evaluation**
REC	**Rehabilitation Engineering Center (DOEd)**
RIS	**Rehabilitation Information System (DOEd) . .**
RRTC . . .	**Rehabilitation Research and Training Center (DOEd)**
RTTC . . .	**Regional Technology Transfer Center (NASA)**
SBA .	**Small Business Administration**
SBDC	**Small Business Development Center**
SBIR	**Small Business Innovation Research**
SDI	**Strategic Defense Initiative**
STTR	**Small Business Technology Transfer Research**
TAIS	**Technology Applications Information System**
USDA	**United States Department of Agriculture**
VISITT . . .	**Vendor information System on Innovative Treatment Technology**

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