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Key Findings and Recommendations for Technology Transfer at the ITS JPO

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14. ABSTRACT (Maximum 200 words)
This report provides key findings and recommendations for technology transfer at the Intelligent Transportation Systems Joint Program Office (ITS JPO) based upon an assessment of best practices in technology transfer in other industries, such as national labs, Federal Agencies, universities and industry. For this project, the assessment of best practices in other industries was comprised of the following components; a literature review to identify best practices; web surveys of technology transfer professionals in other industries and at University Transportation Centers to get the current perspective on technology transfer best practices; and site/telephone interviews to generate 7 case studies of the best practices of selected organizations in other industries. Based upon this assessment, the key findings and recommendations were developed and compared to the recommendations in two previous reports by the Government Accounting Office and the Department of Transportation Office of Inspector General on the ITS JPO.

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Preface/ Acknowledgements

The U.S. Department of Transportation's Intelligent Transportation Systems Joint Program Office (ITS JPO) uses a variety of computer information and telecommunications technologies to improve the productivity and safety of our Nation's transportation system. As part of its new Strategic Research Plan for 2010-14, the ITS JPO has a primary focus on wireless technology including wireless data sharing and data communications between vehicles, passenger devices, and other equipment to help transform and enhance the performance of the U.S. surface transportation system. A key part of the ITS Strategic Research Plan is technology transfer (or "T2"), which involves the transfer of knowledge and skills as well as the transfer of technology to ITS professionals and organizations. The ITS JPO has developed outreach strategies and information dissemination approaches to help facilitate technology transfer, but it realizes that there are other technology transfer methods being implemented by universities, other government agencies, national laboratories, and industries.

This project report comprised of three chapters has been prepared to help the ITS JPO get a better understanding of the technology transfer approaches by others and help identify which of these technology transfer methods are the most applicable to help the ITS JPO grow in this area. The first chapter will discuss the process for identifying best practices in other industries. The second chapter presents six suggested approaches and recommendations for the ITS JPO based upon the review of best practices in other industries. Lastly, the final chapter of this report is a summary of our key findings for this effort.

Acknowledgements
We would like to acknowledge the support and assistance of those who have helped to make this report possible. First, we would like to recognize Stephen Glasscock, Mac Lister and Valerie Briggs from the ITS JPO who provided guidance and support throughout this project effort.

In completing this report, we appreciate the support of our partner Texas Transportation Institute (TTI) on this project. Two individuals from TTI made an outstanding contribution, Katie Turnbull and Melissa Tooley. In addition, the individuals from Battelle team that made significant contributions to this work are Carol Zimmerman, Denny Stephens, Stephen Andrade, Elizabeth Busch-Craig, Jean Noethlich, Ryan Helwig, Mitch Horowitz and KyLynn Slayton.

Finally, on behalf of the project team, we would like to thank all of those organizations that responded to our survey or agreed to participate in our interviews for the case studies. We especially thank the representatives at the Software Engineering Institute, NASA Glenn, Penn State University, Maryland TEDCO, yet2.com, and Project Olympus at CMU. This information was invaluable in helping to validate our findings based upon our literature review and providing additional insight about technology transfer approaches in other industries.

Anthony Gillespie
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Executive Summary

The Intelligent Transportation Systems Joint Program Office (ITS JPO) is responsible for one of the largest research programs in the U.S. Department of Transportation (DOT). The focus of ITS JPO's research program is transformation of the nation's surface transportation systems by using wireless connectivity, computer data, telecommunications, and other advanced technologies to enhance the safety and performance of surface transportation systems. The ITS JPO faces a significant challenge in leading this effort because its research is not directly tied to an implementation program and these systems involve many stakeholders that have diverse interests. The ITS JPO realizes that the transfer of its research results to external organizations in the public and private sectors will be key in helping to further develop, test, integrate, and deploy its research in its effort to enhance the nation's surface transportation system.

At the core of the 2010-2014 ITS Strategic Research Plan is a multimodal surface transportation system initiative, previously called IntelliDrive^{SM} and now known as Connected Vehicle, that has the objective to provide safe, interoperable wireless connectivity between vehicles, network infrastructure and passenger devices to maximize safety, mobility and environmental performance. In addition, to supporting core research, the 2010-14 ITS Strategic Plan supports technology transfer and the knowledge development of ITS professionals throughout the U.S.

To date, technology transfer by the ITS JPO has been conducted primarily through one type of approach – information generation and exchanges. This approach includes workshops, stakeholder working groups, and communicating the results of field tests and model deployments to help involve early adopters in their research. Additionally, the ITS JPO has advanced information on intelligent transportation systems through its ITS Assessment Program by taking the data collected and analyzed from ITS deployments to develop knowledge products for investment decision-makers, planners, operators and maintainers. Through its websites and its electronic documents library at: www.its.dot.gov/index.htm, the ITS JPO distributes its research reports to the public. The ITS JPO transfers its expertise and know-how through its participation in industry conferences and a professional capacity building program that educates professionals in ITS subject matter (www.pcb.its.dot.gov/default.asp).

The ITS JPO realizes that there are many other innovative mechanisms to technology transfer that are being utilized by other government agencies, national laboratories, universities, and industry and would like to learn more about these efforts to see if they could enhance their approach. Therefore, Battelle with support from the Texas Transportation Institute (TTI), a part of the Texas A&M University System and its University Transportation Center for Mobility was brought on as a contractor by the ITS JPO to analyze and compare methods for technology transfer and to provide the ITS JPO technology transfer approaches and recommendations for implementation. This project involves three major components:

- A comparative analysis of technology transfer best practices in other industry sectors – consisting of a literature review to identify examples of best practices, a web survey of technology transfer professionals in other industries to get a current perspective on best approaches in this area, and a survey of the approximately 60 University Transportation Centers (UTCs) in the country that was conducted by TTI through its UTCM.
- Site visits and the development of case studies – this involved conducting 7 site interviews and developing case studies of organizations identified as leaders in technology transfer in other industries.
- Development of recommendations that could be adopted by the ITS JPO for its approach to technology transfer – based upon the findings from the previous two components. This component included comparing these technology transfer recommendations to the recommendations in two previous reports by the Government Accounting Office (GAO) and the U.S. DOT Office of Inspector General (IG) on the ITS JPO.

Summary of the Results T2 Best Practices Analysis in Other Industries

Our analysis of technology transfer best practices in other industries revealed that there are five (5) primary mechanisms for transferring technology that are common across all industries. These best practice approaches summarized in Table ES-1 have been developed by organizations to help facilitate the transfer of technology to or from their respective sector.

Table ES-1: Key Findings of T2 Best Practices

T2 Mechanism	Type of T2 Mechanism	Best Practice Approach (Sector)
1. Licensing	Licenses	❖ On line licenses (National Lab – DOE) ❖ Standardized license agreements (National Lab – DOE) ❖ Software Usage Agreements (DOD, NASA) ❖ Standardized Material Transfer Agreements (USDA) ❖ Leveraging Scientists' Contacts with Industry (NASA) ❖ Socially Responsible Licensing (Universities) ❖ Cross-licensing (Industry)
	Start-Ups	❖ Entrepreneurial Separation Programs (National Lab – DOE) ❖ University Start-Up Companies ❖ Entrepreneurial Courses and Programs (Universities) ❖ Venture Programs and Venture Corporations (National Lab-DOE) ❖ Incubators (DOD, Universities) ❖ Innovation Parks (Universities) ❖ Corporate Venture Organizations (Industry)

Table ES-1: Key Findings of T2 Best Practices (Continued)

T2 Mechanism	Type of T2 Mechanism	Best Practice Approach (Sector)
2. Cooperative R&D	CRADAs and Collaborative Research	❖ Specialized CRADA Agreements (National Lab – DOE) ❖ Standardized CRADA templates (DOD) ❖ Sponsored Research Agreements (Universities) ❖ Material Transfer Agreements (Universities) ❖ Collaboration Agreements (Universities) ❖ Equipment Loan Agreements (Universities)
	Government – Industry Partnerships	❖ Entrepreneur-in-Residence (National Lab – DOE) ❖ University Affiliate and Research Centers (Universities) ❖ Research Consortia (Industry) ❖ Inter-Agency Partnerships (Federal Agencies) ❖ Innovative Partnership Program (IPP) Seed Fund (NASA) ❖ Centennial Challenges (i.e. Innovation Challenge) for Industry (NASA)
3. Technical Assistance	User Agreements	❖ Non-Proprietary and Proprietary User Agreements (National Lab-DOE) ❖ Enhanced Use Agreements (DOD, USDA, NASA) ❖ Use of Facilities by Start-ups or Companies (Universities) ❖ Brokering Excess Facilities or Equipment to Outside Entities in Exchange for Technology or Publications (Industry)
	Work for Others (WFO)	❖ Non-Federal and Federal Work for Others (National Lab-DOE) ❖ Consulting (Universities, Industry) ❖ Staff Exchange Programs (Industry)
	Commercial Test Agreements	❖ Standardized Templates (DOD)
4. Information Exchanges	Formal	❖ Technology Commercialization Portal (National Lab – DOE) ❖ IP Auctions (National Lab – DOE, NASA) ❖ Office of Technology Transition Web-based Tool (DOD) ❖ Websites (DOD, USDA) ❖ Technology Alerts (USDA) ❖ Technology Transfer Workshops (USDA) ❖ Marketing Publications (NASA) ❖ Online Portal Site (Universities) ❖ Social Media Sites (Industry)
	Informal	❖ Publications and Conferences (National Lab – DOE, Universities) ❖ Technology Forums (DOD) ❖ Tradeshow Attendance (USDA) ❖ TechFusion Forum (NASA) ❖ Professional and Technical Societies (Industry)
5. Public Sector Technology Transfer	Assistance	❖ University Technical Assistance Programs ❖ PennTAP Program (Universities)
	Collaborations	❖ National Lab Economic Development Programs (DOE) ❖ Partnership Intermediary Agreements with State and Local Organizations (DOD, USDA)

In addition to these key mechanisms that are used to facilitate technology transfer in other industries, a number of other best practices were identified:

- Numerous Federal laws and policy (~17 laws) have been enacted to shape the processes and mechanisms for Federal technology transfer, which creates a lengthy, complex process to transfer technology. Organizations are creating mechanisms such as standard and pre-approved agreements to simplify this process.
- Successful examples of Federal technology transfer often involve the use of multiple agreements with a company such as a patent license and multiple CRADAs to help transfer a technology.
- Technical assistance is a key technology transfer mechanism that leverages the specialized facilities and personnel to aid partners in the development of technology.
- User facilities are a technology transfer mechanism that is utilized more in the public sector at the national labs and Federal agencies and some universities, but rarely in industry.
- There are a variety of information exchanges both formal and informal that are effectively being utilized for technology transfer.

As a second major component in this project, a report was produced that featured case studies of the technology transfer best practices for 7 organizations in other sectors as shown in Table ES-2. This broad representation of organizations was selected in consultation with the ITS JPO. Individuals from these organizations were interviewed in person at their site location, or by telephone to collect the details that would aid in the preparation of the case studies. The interviews revealed that a variety of mechanisms are used to help facilitate technology transfer. Information exchanges are most frequently implemented across these organizations. In addition, universities implement the largest variety of T2 mechanisms. Three T2 mechanisms identified in the best practices analysis were not discussed as an approach used by any of the organizations during the interviews.

Table ES-2: Summary of T2 Mechanisms Discussed in Case Studies

T2 Mechanism	Type of T2 Mechanism	Type of Organization Interviewed						
		University Transportation Centers (UTCs) – TTI/UTCM	University Technology Transfer Programs #1 – Carnegie Mellon University, Project Olympus	University Technology Transfer Offices (TTOs) #2 – Penn State University	Federal Agencies – NASA Glenn Research Center	Federally Funded Research and Development Centers (i.e. National Labs) – Software Engineering Institute	Industry #1 – Maryland TEDCO	Industry #2 – yet2.com
1. Licensing	Licenses			✓	✓	✓		
	Start-Ups							
2. Cooperative R&D	CRADAs and Collaborative Research			✓	✓			
	Government –Industry Partnerships							
3. Technical Assistance	User Agreements				✓			
	Work for Others (WFO)							
	Commercial Test Agreements							
4. Information Exchanges	Formal	✓	✓		✓	✓		✓
	Informal	✓	✓		✓	✓		✓
5. Public Sector Technology Transfer	Assistance			✓			✓	
	Collaborations						✓	
6. Other	Research Park		✓	✓				
	Technology Maturation or Micro Grant Funding		✓					

For the third part of this project, recommendations and approaches are proposed for adoption by the ITS JPO based upon the findings of the first two phases of this project. A summary of the suggested approaches and recommendations can be found in Table ES-3.

Table ES-3: Summary of Suggested Approaches/Recommendations for the ITS JPO

Suggested Recommendation/Approach	Description
1. ITS JPO Partners Program	❖ Program incorporates a number of ITS JPO activities under a single brand to encourage and support public agencies to deploy ITS technologies, universities to conduct research on key issues, and industries to bring products and service into the marketplace
2. Expand Collaborative Research and Development (R&D) Partnerships in the Public and Private Sector	❖ Activities expanding and/or building upon existing collaborative R&D programs to work with partners in the public and the private sector
3. Establish Research Park Hubs for Transportation Innovation	❖ Establishing physical locations where various stakeholders from government, universities and industry are located to form collaborations and facilitate technology transfer and commercialization
4. Develop a Transportation Commercialization Portal	❖ Creating a single website location for finding information such as patent, patent applications, and marketing summaries for transportation technologies with market potential
5. Expand Small Business Mentoring and Support	❖ Broaden technical assistance and programs for small businesses to help facilitate tech transfer
6. Enhancing Intellectual Property (IP) Identification and Valuing/Creating Market Opportunities	❖ Commit additional resources to examining intellectual property (IP) and understanding business opportunities from transportation research

Details for each of these approaches and recommendations are discussed in chapter 2 of this report.

Chapter 1 – Process for Identifying Technology Transfer Best Practices in Other Industries

The origins of technology transfer can be traced to the early 1900s where it occurred on a small scale at a few universities in the United States, but there were three major activities in the United States that helped this area gain traction. First, in 1945, Vannevar Bush issued his report, “The Endless Frontier” for President Franklin D. Roosevelt. Bush’s report led to creation of many of the Federal agencies such as the National Science Foundation (NSF), National Institute of Health (NIH) and the Office of Naval Research (ONR) that fund and support basic research at institutions throughout the nation.[1] The creation of these Federal agencies established research funding as a critical activity of the Federal government,[2] and it also increased the opportunities for universities to receive funding to perform basic research that could be transferred back to the Federal government or industry.

Second, a University of California researcher, Frederick Cottrell developed an invention called an electrostatic precipitator in the early 1900s. In an effort to license his patented inventions outside the university environment and not conflict with the basic research mission of universities, Cottrell created one of the earliest organizations formed to conduct technology transfer, Resource Corporation. As Cottrell successfully commercialized his inventions, a number of other inventors at his research institution and others began to approach him for advice concerning patenting and licensing in inventions in other areas. This led to the Resource Corporation (whose successor organization – Research Corporation of America – is located in Tucson and was one of the first technology transfer intermediaries) establishing a division in 1946 to manage the patent portfolio and commercialization of these technologies for several hundred universities, such as MIT, until the late 1970s and early 1980s. In addition, other companies were formed during this time period to compete with the Resource Corporation to help facilitate the transfer of technology. It was not until the creation of the Bayh-Dole Act in 1980 that many universities realized the licensing income that could be generated from commercializing their inventions and started to staff technology transfer departments[3].

Third, Federally Funded Research and Development Centers (FFRDCs) were started during World War II when the U.S. government partnered with scientists from academia in laboratories to meet the unique research and development (R&D) needs for the war. FFRDCs are government-owned entities that are privately managed, but are sponsored by Federal agencies to perform research and development and related tasks such as technology transfer. The FFRDCs are sponsored by six agencies – the DOE, the DOD, the Department of Health and Human Services (HHS), NASA, National Science Foundation (NSF) and the Department of Homeland Security (DHS).

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[1] Howard Bremer, “University Technology Transfer: Evolution and Revolution”, Council of Government Relations, 1998.

[2] Ibid.

[3] David C Mowery, and Bhaven N. Sampat, “University Patent and Policy Debates” in the USA, 1925–1980.

According to the NSF, there are three different types of FFRDCs:

- Research and Development (R&D) laboratories (or Federal “national labs”) – perform research in complex technology areas for the agency and transfer technology to the private sector
- System engineering and integration centers – support complex systems for the agency through testing, development, modeling and integration activities
- Study and analysis centers – supply independent analysis and advice in the agency’s core areas through policy development and creating new ideas or approaches on issues.

Technology transfer primarily occurs at the first two types of FFRDCs (i.e. national labs and System Engineering and Integration Centers) because this is where most of the applied research and development is taking place. All of the FFRDCs sponsored by the DOE are national labs, while 5 out of 10 of the DOD FFRDCs are either a national lab or system engineering and integration center. Technology transfer at these FFRDCs is primarily influenced by Federal government regulations and terms in the contractor’s agreement with the sponsoring agency.

For this project, in looking at best practice approaches in other industries, the team examined four industry areas. For the Federal national labs, we decided to focus on DOE and DOD since their sponsor agencies are responsible for approximately 68% of the FFRDCs and they have a research focus in areas that may be similar or complementary to the ITS JPO. We selected three Federal agencies that are three of the five agencies that are most active in technology transfer based upon the annual number of invention disclosures. From a university standpoint, we looked at the University Transportation Centers (UTCs) and universities that reported a high number of annual invention disclosures to Association of University Technology Managers (AUTM) in the electronics and computer information areas, which is similar to the focus of the ITS JPO. Lastly, we examined industry organizations involved with facilitating technology transfer as well as those industries that may interface with the ITS JPO such as computer technology and telecommunications.

Definition of Technology Transfer

Technology transfer is part of the process of moving innovation from bench-level research into the marketplace. There are three critical dimensions that define technology transfer activities and how they are connected to the process of moving research innovation into the marketplace.

Differences between Private Returns versus Societal Impact Shape Technology Transfer Activities

The definition and purpose of technology transfer varies slightly depending upon different institutional perspectives. The AUTM uses a fairly narrow definition that largely reflects the private returns expected by those involved from a university and industry perspective. According to AUTM, technology transfer is the formal process where one party transfers its rights to use and commercialize the new discoveries and innovations that resulted from their basic scientific research to another party.[4]

The Federal Laboratory Consortium (FLC) for Technology Transfer takes a broader view of technology transfer and its impacts on advancing innovations for the benefit of society. According to FLC, Federal technology transfer refers to the processes through which the knowledge and capabilities of Federal

[4] AUTM website – www.autm.net

intramural laboratories and other research facilities can be directed to the research and development (R&D) needs of outside public or private organizations — and through which the inventions and other intellectual assets arising from Federal laboratory R&D can be conveyed to outside parties for development and commercialization.[5]

The critical difference between a private return perspective and a broader societal perspective on technology transfer comes down to the range of activities undertaken to encourage and support technology transfer. Federal agencies and national labs engage in more technical assistance, information exchanges and other engagements with those who might deploy innovations coming out of the Federal laboratory (in some cases regardless of whether the recipient's goal is to generate profitable sales from a commercialized product or service, or to simply adopt a technology for their use (deployment)). Universities function in the middle where they often engage in activities that may provide a return, such as the initiation of licenses and start-up companies, but they also participate in information exchanges, such as workshops and seminars to help get their innovations out of their labs. Industry has a private return perspective where they primarily engage in licenses and contracts to help transfer technology to or from their respective organizations to gain a competitive advantage.

Technology Transfer and Technology Commercialization Are Not the Same Thing

Another important distinction around technology transfer, which is shared across the private return and societal perspectives, is the difference between technology transfer and technology commercialization.

A simple way to explain technology transfer is that at a minimum, it involves the passive management of intellectual property for a research organization. Technology transfer involves disclosure of discoveries, the determination of whether to file for patent protection from both a technical and market perspective, and the licensing of the intellectual property to either a third party organization or the creation of a new business to pursue the creation of the product, process or other intervention based on the discovery and its associated license.

Complementing, but distinct from technology transfer, are more pro-active efforts to commercialize technologies, focused on enhancing technology solutions to meet the need(s) of customers in the marketplace. Technology commercialization is principally involved in product development, and involves proof-of-concept, prototyping and ensuring the ability to scale-up production. From a venture start-up perspective, technology transfer is not sufficient to form a venture, but is at a pre-start-up stage, while technology commercialization is involved in the early stage start-up activities that ensure the commercial potential of a new venture.

Basic and Applied Research Both Involve Technology Transfer But At Different Stages of Development

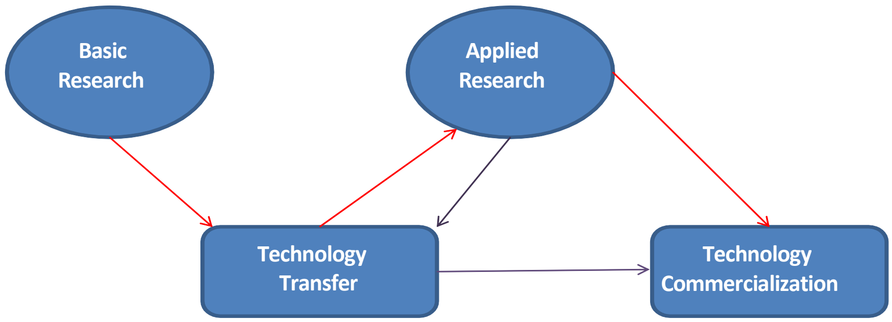
As shown in Figure 1-1, not all research activities are the same, and their differences have implications for technology transfer. The two main types of research leading to technology development are:

- Basic research involving the general search for improved knowledge and understanding. Intellectual property from basic research is based on key discoveries that have the potential to advance new technology.

[5] FLC website – www.federallabs.org

- Applied research involving research to address development of specific applications and solutions using cutting edge technologies. Often applied research involves integration and convergence of leading technologies to solve a problem or develop an application.

Figure 1-1: Technology Transfer and its Connection to Basic and Applied Research



Both basic research and applied research can generate intellectual property and require further technology commercialization to enter the marketplace. But the starting points are different, and what is needed to move forward in terms of technology transfer activities can vary. In particular, a basic research discovery that has intellectual property (IP) potential often needs additional applied research efforts to advance the discovery. For instance, a new research discovery of a key drug target still needs to go through drug development before it can be advanced as a new drug candidate for clinical testing. Similarly, a basic nanotechnology discovery of a new material or structure needs further applied research to develop more specific uses, which then needs to go through prototyping and scale up.

For applied research, the starting point is focused on advancing an application or solution, often involving convergence of multiple technologies. As such, once the applied research is completed it becomes intellectual property that from a technology transfer perspective can then be disclosed, technically evaluated, assessed from a market potential, protected through patents or copyrights, licensed and information on it exchanged. If promising, it can then move into technology commercialization activities with an exclusive partner or number of non-exclusive partners for prototyping and other line product development activities.

Project Approach to Identifying Best Practices

For the ITS JPO program, whose focus is on applied research, the primary emphasis at this time is how to broaden and deepen its technology transfer activities. Of particular importance is to understand best practices. By best practices, our interest is not only on the methods used, but how they are managed. Based upon previous discussions with the ITS JPO program and our research, the project team determined that a technology transfer best practice was the following:

- A leading method in the transfer and management of intellectual property for a research organization that is believed to be very effective at delivering optimal results.

For this project, we looked at the best practices for technology transfer across four industry sectors:

- Federal national labs (for the DOE and DOD) – the focus was on these two Federal agencies because they are involved with supervising the majority of the 37 Federally Funded Research Development centers that include the Federal national labs.
- Federal agencies (DOD, USDA, and NASA) – these agencies were selected because they are three of the top five Federal agencies as measured by annual invention disclosures and patent licenses (the other two are DOE and NIH).
- Universities – particular focus was on leaders in technology transfer such as Massachusetts Institute of Technology (MIT) and Stanford, but the project team also looked more broadly across other public and private universities as well as University Transportation Centers.
- Industry – the focus was on technology transfer intermediaries primarily for the Federal government, but other industries such as computer technology, telecommunications, and electronics as well as consumer products were examined for technology transfer best practices.

The comparative analysis of technology transfer in other industries was conducted in the following two phases to identify best practices from other industries:

1. Literature review of technology transfer best practices
2. Assessment of technology transfer best practices.

The literature review of best practices was initially conducted by performing a keyword search of literature that discusses best practices for technology transfer. The project team developed a list of keywords to search the Internet and find literature resources that discuss technology transfer best practices for other industries. Additionally, the team scanned organizational literature resources from AUTM, Licensing Executives Society (LES) and Federal Laboratory Consortium using these same keywords to help refine the list of best practices for the industry areas.

The literature review provides a broad, historical perspective of technology transfer best practices in other industries, but it does not provide a current perspective. Also, as the first part of this assessment of technology transfer best practices, the project team sent out a web-based survey to 150 technology transfer industry professionals from other Federal agencies, national labs, universities and industry and a survey to 60 UTCs throughout the United States to get their current perspective on the best approaches for technology transfer.

As a second major component in this project, case studies were developed to demonstrate the application of the technology transfer best practices for organizations in other sectors. Individuals in these 7 organizations were interviewed in person at their site location or by telephone to collect the details that would aid in the preparation of the case studies. A broad representation of organizations from different sectors was selected in consultation with the ITS JPO to interview for the case studies.

These two major components were the basis for the recommendations and approaches that were proposed for implementation by the ITS JPO.

Chapter 2 – Suggested Approaches and Recommendations for the ITS JPO

Research by itself will not translate into being transferred, commercialized and developed into a new product by the public or private sector without having a support infrastructure in place to help move it through these various development stages. There are many different players that need to participate in the support infrastructure for translating research into a commercial or public product, and they all have diverse interests and expectations. On one side of the spectrum at the early stage of technology development, the Federal government will primarily fund the research enterprise for the generation and validation of new ideas and aid in transferring the technology, but they do not typically provide funding for commercialization and product development. Other research institutions such as universities and non-profits focus on receiving funds from the Federal and state governments and corporate sponsors for their research. At later stages of the technology development process, companies (both start-up and established) focus on receiving funding from venture capitalists and internal sponsors for commercial ready technologies. This situation creates a gap where there is no group focusing on helping to transfer and commercialize basic and applied research. The gap is wider in the current economic environment where companies are becoming even more risk adverse in acquiring technologies that will require an additional investment for introduction into the marketplace.

A similar situation is happening with the ITS JPO. As part of a Federal government agency, it provides funding for research and some basic assistance for transferring technology, but it does not have a formal technology transfer program and has expected those public and private entities that they have transferred their research to use their own resources to commercialize and create new products. The primary method that they have used to help facilitate the transfer of their research is through information exchanges – consisting of their electronic document library of research, participating in industry meetings and conferences, educating professionals through a professional capacity building program, and other information posted on the website. The ITS JPO has primarily seen some deployment of their research where it has been commercialized and developed into products for the public sector, but not much activity in the private sector. In order for the ITS JPO to increase its level of technology transfer activity, it will need to look at developing and implementing technology transfer approaches that will provide more direct assistance and support to those public and private organizations that will transfer and commercialize their research into new products.

In this chapter, Battelle provides some suggested approaches and recommendations based upon its analysis of technology transfer best practices in other industries that can be potentially implemented by the ITS JPO to help it grow in the area of technology transfer. Six approaches and recommendations are presented. In addition, the chapter includes a comparison of the approaches and recommendations with recommendations from two past reports on the ITS JPO.

Suggested Approaches and Recommendations

Approach 1: ITS JPO Partners Program

Description

The ITS JPO Partners Program can provide a comprehensive T2 effort to focus on increasing the coordination, communication and collaboration among public agencies, universities, and industries by leveraging the information exchange capabilities of the ITS JPO. For this effort, a number of T2 activities underway at the JPO, such as the ITS Professional Capacity Building program, as well as new activities and initiatives could be incorporated under the ITS JPO Partners Program “branding.”

Rationale

The ITS JPO has a number of information exchange tools such as an electronic library, professional capacity building, and social media sites (e.g. Facebook and Twitter) and other approaches that have been implemented to help foster the transfer of technology by providing information about their research. Opportunities exist to further leverage this capability through the establishment of the ITS JPO Partners Program. Putting all of these activities under the ITS JPO Partners Program brand, would establish stronger linkages among the various stakeholders. The program has the potential to encourage and support public agencies to deploy ITS technologies, universities to conduct research on key issues, and industries to bring products and service into the marketplace, while fostering interaction and coordination among Federal agencies, state and local agencies, universities, and industries to advance the use of ITS to improve the operation of the transportation system.

The ITS JPO Partners Program could be focused on addressing a number of issues: 1) strengthening the links between the JPO and public agencies, universities, and industry; 2) building a sense of community within each of these groups and across all groups – where everyone is part of the JPO Partnership; 3) helping link university researchers with industries to bring promising technologies and products to the marketplace; and 4) providing public agencies with a support network for testing and deploying new technologies, procedures, and polices.

Best Practice Models

The ITS JPO Partners Program draws on elements from a number of the T2 best practices and case studies documented in Appendix A and C. The following case studies utilize some of the elements included in the ITS JPO Partners Program.

- NASA Glenn – Information Exchanges to leverage knowledge and use of a website.
- Carnegie Mellon University’s Project Olympus – Showcase Forum events and Show and Tell events to promote new technologies, products, and services and to match industries and universities with users.
- Software Engineering Institute – Partnership Networks, eLearning on-line courses, and web seminars.
- Texas Transportation Institute (TTI)/University Transportation Center for Mobility (UTCM) – Transit Systems Technology User Groups to share experiences with new technologies and applications.
- Maryland TEDCO – Showcase events with other groups to facilitate the transfer and the commercialization of technologies from state and Federal agencies, institutions, and industries.

Activities

The ITS JPO Partners Program includes a number of activities. Some of these activities are targeted toward all three groups – public agencies, universities, and industries – while others are directed to just one group. The following examples highlight activities to be conducted under the ITS JPO Partners Program.

- Marketing the ITS JPO Partners Program. The first activity focuses on marketing the new ITS JPO Partners Program. Activities include developing a logo, a marketing/information brochure, implementing a new part of the JPO webpage, and conducting outreach to all groups. Outreach activities may include the use of social media, articles in targeted publications and newsletters, presentations at conferences, and utilization of listserves.
- Implementing an Interactive Webpage and other Social Media. Enhance the ITS JPO Partners Program webpage and other social media to include interactive features, allowing the JPO and other Federal agencies, public agencies, universities, and industries to interact on a regular basis to promote coordination and cooperation on developing, deploying, and operating ITS. For example, the JPO can provide information on critical research needs that university partners can pursue. Universities can post information on licensing opportunities for industries. Industries can post information on their products for public agencies. Public agencies can post needs for products and share experiences with other agencies.
- ITS JPO Partners Showcases. These showcases could be held at ITS America, AASHTO, TRB, and other appropriate meetings and conferences. They will provide opportunities for interaction among partners (agencies, universities, and industries). The intent of the Showcases is to link groups with similar interest and help link research with licensing and product development opportunities.
- Training. This activity could build and expand on current training efforts used by the JPO, other Federal agencies, and other organizations. A wide range of techniques, including on-line courses, web seminars, workshops, and conferences could be used to provide training on different topics. New material could be developed and delivered on intellectual property, invention disclosure, licensing, and commercialization.
- Partnership Networks and User Groups. Partnership Networks and User Groups could be established around specific topics and issues. These networks and groups could provide support to different subgroups or be organized around different topics of interest.
- ITS JPO Partnership Program Awards. This element of the program could recognize best practices, innovative partnerships (including ITS challenges and competition initiatives), and advances in deployment. Recognizing successful activities and efforts is a key element to maintaining support and ongoing participation. The awards could be presented by the RITA Administrator or other high-ranking official at a high-profile event, such as TRB, ITE, or ITS America meetings and conferences.

Potential Impact

The ITS JPO Partnership Program could have the following outcomes:

- Increase in the communication and coordination among and between the JPO, other Federal agencies, state and local agencies, universities, and industries
- Additional research targeted to key issues
- Increase in the linkages between universities and industries

- Increase in the deployment and operation of ITS to improve the operation of the transportation system
- Advance the development and deployment of new technologies and processes
- Create a sense of community among public agencies, universities, and industries to help energize these groups to enhance a culture of innovation
- Benefit all groups, including the traveling public and freight shippers.

Approach 2: Expand Collaborative Research and Development (R&D) Partnerships in the Public and Private Sector

Description

Technology transfer can be enhanced through maintaining and expanding collaborative research and development partnerships by the ITS JPO in both the public and private sectors. It also provides a path to broaden these types of partnerships, which could be accomplished by the ITS JPO looking at expanding and/or building upon existing collaborative R&D programs to work with partners in the public and the private sector.

Rationale

Cooperative research is a primary mechanism for technology transfer. This mechanism fosters the transfer of joint research developed between the Federal agencies and industry/universities or Federal agencies and multiple firms to the private sector. Federal agencies such as the ITS JPO can facilitate the transfer of technology through cooperative research by granting intellectual property to the party (or parties) that are participating in the research effort.

Numerous studies have shown that fast-growing, technology-oriented economies are typically anchored by major research institutions interacting with a robust technology-oriented private sector. The presence of research institutions, in and of itself, however, does not necessarily lead to technology transfer and economic development; rather, it is when the research interests of the researcher from government, university or industry are aligned with a collaborative partner(s) that have a good understanding of how to transfer and commercialize a technology into new product discoveries for the marketplace.

Key shifts are taking place in how R&D is conducted, demanding new types of strategic alliances to gain competitive advantages from research capabilities. With the decline of major corporate research laboratories and a focus by corporations on diversifying the sources of innovation upon which they draw, there is a rising need for strategic alliances across research institutions and industry (such as government-industry, university-industry, industry-industry) to fill the demand for innovation. This situation creates an opportunity for the ITS JPO to build upon its current collaborative R&D partnerships such as MOUs with the European Union, Japan and the National Weather Services and expand in this area in the future.

Best Practice Models

There are a number of T2 best practices and case studies that the ITS JPO could look at as potential approaches that could be implemented into their future collaborative R&D efforts such as:

- Industry Consortia – Both SEMATECH and EPRI were formed as government-industry partnerships that formed regionally based organizations to collaborate on R&D to solve a complex problem or solution.

- USDA-NASA – A memorandum of understanding (MOU) was formed by these two agencies to help promote Showcase Forum events and Show and Tell events for new space-related biological and environmental technologies, products, and services, and to match industries and universities with users.

Activities

The enhancement of collaborative R&D by ITS JPO includes a number of activities. Since, the U.S. DOT has established partnerships with the university sector through the University Transportation Centers and other programs, these suggested activities are focused on establishing partnerships with industry and government through the following efforts:

- Consortia
  U.S. DOT RITA recently started a Transportation Research Collaboration Pilot website (http://www.transportationresearch.gov/Pages/index.aspx) for electronic sharing of information identified in 14 thematic research areas or clusters for researchers to better collaborate and share ideas. The ITS JPO could focus on expanding the pooled fund program where government, university, or industry stakeholders from a respective cluster area can put their funding together to collaborate on research or fund a challenge/competition to solve a problem or create a solution in the ITS area.

- Inter-Agency Partnerships
  The ITS JPO could form government-government collaborative R&D partnerships by working with other Federal agencies that perform similar or complementary research. They could co-sponsor events to promote technologies, products and services and help foster partnerships among the various stakeholders from industry, Federal agencies, small businesses, universities and other groups. For example, the ITS JPO could establish a partnership with the Department of Energy (DOE) to cross-market transportation related technologies and jointly sponsor collaborative research on energy-related applications.

- Regionally-Based Co-Op Efforts
  Another partnership where the ITS JPO could build and/or expand its presence is with the state DOT agencies, programs (such as the Local Technical Assistance Program (LTAP), Tribal Technical Assistance Program (TTAP), and organizations (such as the American Association of State and Highway Transportation Officials (AASHTO) Technology Implementation Group (TIG)). The ITS JPO could directly facilitate or work with the FHWA and FTA the formation of regionally based partnerships allowing groups to leverage their know-how, skills and training in the development and deployment of transportation technology.

Potential Impact

The likely potential impact of the ITS JPO establishing these R&D partnerships in the public and private sector is the following:

- Help drive and catalyze public-private transportation markets
- Engage the public-private sector through the facilitation of these collaborative R&D efforts.

Approach 3: Establish Research Park Hubs for Transportation Innovation

Description

The ITS JPO could establish research park hubs for transportation innovation to help facilitate technology transfer. The research hubs would be physical locations where various stakeholders from government, universities and industry are located in close proximity to each other to help form collaborative partnerships and facilitate activities in technology transfer and commercialization among these different groups. Similar to the Federally Funded Research and Development Centers (or national labs), the US DOT could leverage its university-based centers of excellence, University Transportation Centers, or Turner Fairbank's Highway Research Center to assist in establishing these transportation research hubs.

Rationale

Research parks are a well-known approach for helping to advance partnerships between government, university and industry to accelerate the pace of technology transfer among these groups. Battelle in collaboration with the Association of University Research Parks, performed a survey of 174 university research parks in the U.S. and Canada in 2007 and found that research parks have continued to grow in the last three decades with an increased focus on targeted industry clusters, incubation, and entrepreneurship, and they are viewed as a tool to spur business retention/expansion and economic development in the areas that they serve. Some of the government national labs and Federal agencies in the Department of Energy and Department of Defense have already started to implement this approach as revealed by the research park survey. The ITS JPO could use a similar approach for the transportation sector.

Best Practice Models

There were a number of research parks and case studies by Federal agencies, national labs and universities documented in Appendix A that the ITS JPO could further examine to develop their efforts:

- Oak Ridge National Laboratory – Established research park facilities for private companies either directly on campus of the national lab that offers the lab's scientists an opportunity to collaborate with these companies and form partnerships between the lab and the company.
- Sandia National Laboratory – Formed the Sandia Science and Technology Park, a partnership between the Department of Energy, the City of Albuquerque, Technology Ventures Corporation and Sandia to foster activities in technology.
- Pacific Northwest National Laboratory – The Tri-Cities Science and Technology Research Park is a facility for private companies to work with the lab scientists located close to the lab.
- NASA Ames Research Center – Created a research park at NASA Ames to help foster collaboration between companies and the research center.

Activities

The research park hubs for transportation innovation could include the following activity to build upon the existing center of excellence infrastructure at universities established by the UTC program:

- UTC Program Expansion (to include Transportation Research Park Hubs)
  This activity could involve the expansion and enhancement of the mission of the UTCs to focus on integrating government-university-industry partnerships at these current sites to help create an environment for innovation with a free and frequent information exchange between these groups.

Potential Impact

The probable potential impact of the ITS JPO establishing these research park hubs for innovation is the following:

- Increased rate of technology transfer through the increased interaction between the researchers and partners interested in potentially transferring and commercializing the technology
- Better integration of research (since industry can be involved at the early research stages) that can lead to solutions that can be implemented in the marketplace
- Growth and enhancement of the pool talent in the transportation sector by having a various stakeholders collaborating and located in close proximity to each other.

Approach 4: Develop a Transportation Commercialization Portal

Description

The transportation commercialization portal is an opportunity to help grow technology transfer for the ITS JPO by enabling potential customers primarily in the private sectors such as entrepreneurs, companies and investors to find transportation technologies. The transportation commercialization portal provides an opportunity for those stakeholders that are interested in finding a single location with information such as patent, patent applications, and marketing summaries for transportation technologies with market potential. This approach could also be coordinated as part of the ITS JPO Partners Program.

Rationale

Commercialization portals offer an opportunity to list available technologies that have been patented. These commercialization portals also provide greater value in listing innovative technologies, such as software and research tools that can help foster technology transfer through the acceleration of research or can facilitate the bundling of technologies to create a product for commercialization, or feature programs fostering technology transfer/commercialization. The ITS JPO provides a technology transfer website that presents a great deal of information about the research and deployment of technologies, but industry or potential commercial partners cannot easily find what are the available transportation technologies. The ITS JPO has some patented technologies to be included as part of the transportation commercialization portal, but it would be of greater value as the ITS JPO continues to develop more technologies that may not require patent protection such as advanced wireless communication software and other software applications in the future.

Best Practice Models

There are a number of technology transfer best practices featuring technology commercialization portals that are presented in Appendix A and C such as the following:

- DOE Technology Commercialization Portal – A portal with patents, patent applications and marketing summaries for DOE technologies that are available for licensing
- FHWA Market Ready Technology and Innovations – A portal site by the Federal Highway Administration (FHWA) that provides a listing of research and technology initiatives.

- Yet2.com – An online marketplace where clients can list their available technologies for prospects to purchase
- iBridge Network – An online portal site where research institutions (primarily universities) can list their available technologies.

Activities

A number of activities could be included in the technology commercialization portal. These following activities could build upon the existing ITS JPO website and the ITS JPO Partners Program to expand it to include the available technologies and feature new programs that are created to support technology transfer and commercialization:

- Create Patent and Marketing Content for Portal
  - Inventory of US DOT Patents – This first activity could involve collecting the available patents and patent applications by the US DOT from the US Patent and Trademark Office (USPTO).
  - Assess Market Potential of Technologies – This step could make sure the technologies with a market application are placed in the portal.
  - Generate Marketing Summaries – During this process, details about potential market applications could be developed.
  - Add DOT patents and marketing summaries to the ITS JPO website – This step could involve putting the list of available patented technologies and marketing summaries on the existing ITS JPO website.
- Develop a list of the U.S. DOT technology challenges, such as the Connected Vehicle Technology Challenge to be placed on the portal.

Potential Impact

The transportation commercialization portal could result in increase communication and coordination among and between the JPO, other Federal agencies, state and local agencies, universities, and industries. It will result in more research targeted to key issues, increased links between universities and industries, and increased deployment and operation of ITS to improve the operation of the transportation system. The following are likely potential impacts of the transportation commercialization portal:

- Facilitation of information exchanges
- Increased awareness of available technology
- Improved access to available technology

Approach 5: Expand Small Business Mentoring and Support

Description

Small business mentoring and support is another approach that the ITS JPO could implement to help support their technology transfer efforts. Often, small businesses and entrepreneurs elect not to pursue the transfer of technology from the government because of the following reasons: 1) Lack of resources to spend the time understanding the available technology; 2) Not enough time or resources to invest in understanding the processes and regulations for licensing the technology; or 3) Lack of awareness of the available technologies, research facilities and programs offered to small businesses by the government. By expanding its technical assistance and programs for small businesses, the ITS JPO can expand its outreach to this segment and the transfer of technology.

Rationale

Small businesses provide a great deal of technology innovation, but need support to help grow and prosper – especially when working with the Federal government due to the additional regulatory requirements that makes the transfer of technology more complicated when compared to this process in other sectors. These small enterprises need resources such as management and technical talent, technology, connections to sources of capital, and other support services to continue to operate. They often need assistance to determine the market potential and economic feasibility of technology. They may also need access to specialized equipment and laboratories and technical expertise to help solve technical issues that arise after the technology has been transferred during the technology commercialization and product development stages prior to launching the product in the marketplace. Based upon our research and experience, states and regions that have a history of small business and entrepreneurial development have three inter-related components to foster efforts in this area: 1) a network of individuals experienced in this area to help the less experienced through advice and counsel; 2) business and technical support resources such as service providers and consultants to support new enterprises and entrepreneurs with market and/or technology assessments; and 3) specialized equipment and facilities to foster development of technology.

The U.S. DOT already has a Small Business Innovation Research (SBIR) Program that consists of multiple phases to help provide support to small businesses that are attempting to commercialize research from the areas of interest in the US DOT offices such as the ITS JPO. Recently, Congress passed legislation to increase funding for the first two phases of the SBIR program for the majority of the Federal agencies (including U.S. DOT) to the following: phase 1 was recently increased from $100K to $150K for a period of six months to conduct feasibility studies on R&D submitted by the US DOT offices; phase 2 was recently increased from $750K to $1 million for a period up to two years for companies that were awarded a phase 1 SBIR award to develop and commercialize these technologies; and for phase 3, the SBIR phase 2 awardees are expected to find an outside source of funding other SBIR funding to help further pursue the commercialization of the technology.

The ITS JPO could expand upon the small business mentoring and support by building upon the resource support provided by the SBIR program. There is an opportunity for the ITS JPO to provide support similar to what the DOD has put in place for SBIR Phase 2 companies that are advancing toward phase 3 stage. In addition, the ITS JPO should expand its resources to provide business and technical support for small businesses and entrepreneurs.

Best Practice Models

There are a number of best practice models and case studies discussed in Appendix A and C, and the ITS JPO could potentially implement all or part of these efforts to help with expanding its approach for providing small business mentoring and support:

- Project Olympus at Carnegie Mellon University – This university sponsored program support technology transfer by helping to provide business and entrepreneurial support services to students and faculty through the following methods:
    - Information exchanges – Project Olympus staff that is experienced in entrepreneurship provides information and advice to aid faculty and students interested in entrepreneurship.
    - Incubator space – Dedicated space on campus is leveraged by Project Olympus to help the transfer of technology to newly formed start-up companies run by students and

faculty. The close proximity of this space to their other activities on campus helps the students remain more actively involved in the company.

    - Technical assistance – This assistance is provided by Project Olympus staff through micro-grant funding support and the advice provided by their internal staff and external service providers through one-on-one meetings and showcase forum events.

- Navy Transition Assistance Program (TAP) – An external service provider, Dawnbreaker Inc., supports the U.S. Navy Phase 2 SBIR awardees with accelerating the transition of their technology into the marketplace as they move toward Phase 3 stage of their SBIR award. Some of the support services provided by Dawnbreaker to the Navy SBIR Phase 2 awardees are business assistance, market research, marketing outreach and other services.

Activities

The ITS JPO could implement a number of activities to help expand its small business mentoring and support efforts. The following activities could build on existing programs in the U.S. DOT to help support small businesses:

- Networking activities – The ITS JPO could hold networking activities similar to the showcase forum events by Project Olympus or kickoff events in the TAP where small businesses and entrepreneurs become aware of transportation related technologies and how to gain access to the technology.
- Small Business Partnering activities – The ITS JPO could offer opportunities for small businesses to partner with large firms such as the kickoff event offered as part of the Navy TAP.
- SBIR T2 Program – Similar to the micro-grant funding support provided by Project Olympus, and the SBIR T2 approach emerging in other Federal agencies (e.g. NIST and NIH), the ITS JPO could take a portion of its SBIR funding to support small businesses with the transfer of their technology. This funding support could occur when the technology is ready to move beyond the phase 2 SBIR stage (i.e. phase 2b) and a research gap still needs to be addressed in order to make it more attractive for a potential commercial investment.

Potential Impact

Through these efforts a number of probable potential impacts can be achieved by the ITS JPO:

- Growth in the network of small businesses and entrepreneurs with transportation related businesses
- A greater leverage of resources and assets through networking and collaboration
- An increase in partnerships between small businesses and large companies, hopefully resulting in an increased survival rate of small businesses.

Approach 6: Enhancing Intellectual Property (IP) Identification and Valuing/Creating Market Opportunities

Description

Another approach that the ITS JPO could consider to aid technology transfer efforts is to enhance the processes for identifying intellectual property and valuing market opportunities. Similar to many research institutions, the ITS JPO has focused its resource support on its research efforts. To take full advantage of these efforts, the ITS JPO could commit additional resources in examining IP and understanding business opportunities from transportation research to help its technology transfer efforts.

Rationale

The ITS JPO has taken a traditional approach to technology transfer (similar to the majority of Federal agencies) with a focus on knowledge and research dissemination primarily through publications and the JPO website to help prospects identify and value/create market opportunities for these technologies with a limited number of internal resources focused on technology transfer. This approach creates a situation where the internal resources (which may often have shared responsibilities) involved with technology transfer are stretched to their limit in trying to keep up with identifying intellectual property and valuing/creating market opportunities from the large volumes of internal research. Therefore, they tend to prioritize their work on selected opportunities that have greatest market potential and the shortest time to market and miss out on identifying IP and valuing/creating market opportunities from other research that may require more effort. Additionally, because of the lack of resources involved in technology transfer, there may rarely be anyone looking at externally developed research technology that may be brought back into the organization to meet their needs. Therefore, the ITS JPO should bring in additional resources (either internal and/or externally) to help them identify IP and value/create opportunities from technology created internally as well as externally.

Best Practice Models

The ITS JPO Partners Program could consider the following technology transfer best practices and case studies presented in Appendix A and C to help them enhance their approach for identifying IP and valuing/creating market opportunities:

- NASA Glenn Research Center
    - External Consultant Assistance – For technologies that have been approved by the internal NASA technology transfer staff at the monthly technical evaluation meeting, an external consultant, Fuentek LLC is utilized to perform a market assessment of technologies.
- NASA Goddard Research Center
    - IP Auctions – An IP service and consulting company, Ocean Tomo, was used by NASA Goddard to auction five software code patents as part of an exclusive license to the selected bidder.
- Yet2.com – provides consulting services (i.e. patent brokering services) to help numerous clients in the public and private sectors identify IP and value/create market opportunities for their technologies or from those external parties in their clients' sector.

Activities

ITS JPO could include a number of activities in its approach for enhancing the identification of IP and valuing/creating market opportunities. The following activities could help the ITS JPO improve its technology transfer by expanding the internal/external resources needed for looking at potential IP and market opportunities from its research:

- Due Diligence – Identification of technologies from research such as using the services of a patent broker, Ocean Tomo or yet2.com or a partnership intermediary such as Maryland TEDCO.
- Market and Technology Assessments – Determining the market potential of a technology by using the services of an external provider such as Fuentek or forming an internal committee to assess technology such as NASA Glenn.
- Engineering Optimization – Developing a product from the technology that can be mass produced such as services provided by the National Institute of Standards and Technology (NIST) supporting manufacturing extension programs (MEP), which help small and medium manufacturing enterprises deploy technology.

Potential Impact

The likely potential impact of the ITS JPO enhancing its IP identification and value/creating market opportunities for transportation research is the following:

- An increase in the number of transportation technologies transferred to and from the private sector
- Increases in industry partnering from the ITS JPO to the public and private sector
- Improvements in the transition of research from the ITS JPO to the public and private sector.

Comparison of T2 Recommendations to the ITS JPO Reports

A review of two reports on the ITS JPO by the Government Accounting Office (GAO)[6] and the DOT Office of the Inspector General (IG)[7] was performed to help determine how the recommended technology transfer approaches compared to the recommendations in these respective reports.

Comparison of T2 Recommendations to the DOT Office of IG Report

The DOT Office of the IG report, "The Joint Program Office's Management of the Intelligent Transportation Systems Program Needs to be Improved" made recommendations for improvement to the ITS JPO, and only one recommendation related to technology transfer: " Strengthen the assessment program and require contractors more effectively measure and report ITS research project results." Better reporting of research results could be broadly construed as T2 in that findings may be useful in identifying new technologies and applications and their market potential. This

[6] Government Accounting Office, "Highway Congestion: Intelligent Transportation Systems' Promise for Manage Congestion Falls Short, and DOT Could Better Facilitate Their Strategic Use", GAO-05-943, September 2005.
[7] U.S. Department of Transportation Office of Inspector General, "The Joint Program Office's Management of Intelligent Transportation Systems Program Needs to be Improved", Report Number: AV-2009-040, March 11, 2009

information, in turn, could be folded into one or more of the T2 approaches and recommendations in this study.

Comparison of T2 Recommendations to the GAO Report

For this assessment, there were three recommendations in the GAO report for the ITS JPO that were compared to the six T2 approaches and recommendations for the ITS JPO. When comparing these two different groups of recommendations in Table 2-1, there were a number of the T2 approaches that complemented the GAO recommendations. The GAO recommendations in the report were focused on methods to improve the deployment of ITS JPO technology, which involves technology transfer. The following provides a discussion of how the T2 approaches complement each of the respective GAO recommendations:

Table 2-1: Comparison of T2 Approaches to GAO Recommendations

GAO Report Recommendation	T2 Approach
1. Develop new strategies to better advertise the availability of federal funds for operating ITS technologies.	**ITS JPO Partners Program** - Single brand for ITS JPO deployment activities such as showcases, user groups and social media that would help market the funding available for the operation and development of ITS technology. **Collaborative R&D Partnerships in the Public and Private Sector** - Through collaborative research and development between the public and private sector, the knowledge of using federal funds for operating ITS technologies can be more easily exchanged. **Transportation Commercialization Portal** - A single location for providing information regarding the funds available for operating ITS technologies. **Small Business Mentoring & Support** - By assisting small businesses, the ITS can encourage the participation of small businesses as well as show the availability of federal funds for operating ITS technologies.
2. Encourage cost-effectiveness analyses and their use in transportation planning and decision making.	**ITS JPO Partners Program** - The training and showcase activities are examples of some of the efforts that could be leveraged to encourage cost effectiveness analysis for transportation planning and decision making. **Transportation Commercialization Portal** - The commercialization portal is a single location where cost effectiveness analysis based upon deployments could be located. **Intellectual Property (IP) Identification and Valuing/Creating Market Opportunities** - This is an approach that could contribute to demonstrating the benefits and the impact of a deployed technology.
3. Revise measures for ITS deployment to incorporate local needs and operational status for deployed ITS technologies.	**Transportation Commercialization Portal** - The portal offers an opportunity for a single location to present information regarding deployment and operational status of ITS technologies by state and local agencies

As shown in the Table 2-2 below, all of the potential T2 approaches with the exception of the research park hubs can play a role in complementing the GAO recommendations. The research park hubs would require capital funding in order to be implemented. Therefore, it is not a fit with the GAO recommendations.

Table 2-2: Summary of the Comparison of T2 Approaches to GAO Recommendations

GAO Report Recommendation	Potential T2 Approaches					
	ITS JPO Partners Program	Collaborative Research and Development (R&D) Partnerships in the Public and Private Sector	Research Park Hubs for Transportation Innovation	Transportation Commercialization Portal	Small Business Mentoring and Support	Intellectual Property (IP) Identification and Valuing/Creating Market Opportunities
1. Develop new strategies to better advertise the availability of federal funds for operating ITS technologies.	✓	✓		✓	✓	
2. Encourage cost-effectiveness analyses and their use in transportation planning and decision making.	✓			✓		✓
3. Revise measures for ITS deployment to incorporate local needs and operational status for deployed ITS technologies.				✓		

Chapter 3 – Summary and Conclusions

Although, some progress has been made by the ITS JPO in facilitating the transfer of their research through information exchange methods such as professional capacity building, electronic document library and outreach via workshops, stakeholder working groups, testing and models deployments, it is shown by our analysis of technology transfer best practices in other industries that simply focusing on the research base, important as it is, does not by itself create the technologies and innovations for the marketplace. The ITS JPO has an opportunity to implement a number of the following approaches to help increase the impact of it technology transfer efforts in the future:

1. Developing a new branding effort, the ITS JPO Partners Program, for its outreach activities
2. Expanding existing collaborative R&D partnerships in the public and private sector
3. Establishing public-private research parks for transportation innovation
4. Creating a transportation commercialization portal
5. Broadening and diversifying its collaborations with small businesses through expanded mentoring and support
6. Adding resource support to examine intellectual property and understand business opportunities from the ITS JPO research.

By supplying more direct assistance and support to those stakeholders who will transfer and commercialize their technology to close the gap between basic/applied research and commercial ready technology, the ITS JPO can increase its technology transfer activity and continue to grow in this area by implementing these approaches in the future.

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21. "The Joint Program Office's Management of Intelligent Transportation Systems Program Needs to be Improved", U.S. Department of Transportation Office of Inspector General, Report Number: AV-2009-040, March 11, 2009.

22. "University Lab Partnerships", Argonne National Lab Presentation, 2009.

APPENDIX A: T2 Best Practices in Other Industries Based Upon Literature Review

The details regarding the technology transfer best practice approaches for other industries are presented in the following sections that deal with the T2 environment of policy, management and intellectual property (IP); and T2 mechanisms.

A. T2 Environment – Policy, Management and IP

This section discusses the T2 environment from the standpoint of the policy and guidelines, management and operation, and IP identification.

1. Policy and Guidelines

The following describes policy guidelines for four groups: DOE national labs, Federal agencies, universities, and industry.

Key Metrics for DOE National Lab Technology Transfer

Technology transfer at the national labs sponsored by the Department of Energy tracks the following key metrics:

- Licenses
- Co-op Agreements (including CRADAs)
- Technical Assistance
- Nonfederal WFOs Agreements
- User Facility Agreements
- Exchange Programs
  - No. of scientists working in industry
  - No. of internships at national labs
- Informal collegial exchange
  - No. of Publications
  - Conferences

DOE National Labs

Technology transfer policy for the national labs is set by the sponsoring agency, the Department of Energy. According to the January 2008 policy statement on technology transfer by the Secretary of Energy, "technology transfer is defined as the process by which knowledge, intellectual property, or capabilities developed at DOE national laboratories are transferred to any other entity, including private industry, academia, state, and local governments, or other government entities".[8]

According to the GAO 09-548, report on DOE technology transfer, the Atomic Energy Act of 1954 and the Federal Nonnuclear Energy Research and Development Act of 1974 are policy guidelines focused solely on DOE technology transfer. These acts authorize the following:

- DOE is provided with the option to waive its claim to inventions created under a DOE contract
- Contractors are allowed to retain title to inventions at the labs, obtain IP protection and license the invention to others

From a DOE national lab perspective the following activities are considered technology transfer:

- Licensing
- Cooperative Research and Development Agreements (CRADAs)

[8] Government Accounting Office, "Clearer Priorities and Greater Use of Innovative Approaches Could Increase the Effectiveness of Technology Transfer at Department of Energy Laboratories", GAO-09-548, June 2009

- Nonfederal work for others
- User Facility Agreements

Other activities that may or may not be considered technology transfer depend upon DOE representative and could involve efforts of sharing the laboratories' technology, capabilities or knowledge such as Federal work for others (WFOs). This may not be considered technology transfer by some because it does not involve the transfer of technology to private industry – instead the transfer is to another Federal agency[9].

Federal Agencies

Three Federal Agencies are discussed below: DOD, USDA, and NASA.

Department of Defense. The policy for technology transfer at the DOD national labs and other Federal agencies is led by the sponsoring agency, the Department of Defense. The focus has traditionally been on licensing technology out to academia and industry, but the DOD has also started to increasingly look at the possibility of transferring technology back into the Federal government, a process called "technology transition." Technology transition is becoming more popular because it helped to generate advances that have benefited the DOD and the needs of the warfighter. A complement to this is "technology insertion" in which DOD encourages prime contractors for major systems to consider integrating these promising component technologies developed by small businesses and others into those systems. This has become a frequent practice in the Small Business Innovation Research (SBIR) program. The Office of Naval Research's (ONR's) Technology Insertion Program for Savings (TIPS) is a leading example of this approach.

Key Metrics for DOD Technology Transfer

- Technology transfer at the Department of Defense tracks the following key metrics:
- Licenses
- Co-op Agreements (including CRADAs)
- Technical Assistance
- Nonfederal Reimbursable Work
- User Facility Agreements

From a DOD perspective, the following are key technology transfer activities:

- CRADAs and Cooperative agreements
- Contracts
- Education Partnerships
- Exchange of personnel
- Exchange of Technical data, grants, other transactions
- Partnerships with universities
- Patent License agreements
- Presentation of technical papers
- Technical Assistance
- Technology Assessments

[9] Ibid

US Department of Agriculture. The technology transfer policy as well as approvals, licensing and marketing[10] for the USDA is centralized at the Office of Technology Transfer (OTT). ARS (Agricultural Research Services) has been delegated authority by the Secretary of Agriculture to administer the patent program for ARS, and the technology licensing program for all intramural research conducted by USDA.[11] ARS's OTT is assigned the responsibility for protecting intellectual property (IP), developing strategic partnerships with outside organizations, and performing other activities that effectively transfer ARS research outcomes and technologies to the marketplace.[12]

Key Metrics for USDA Technology Transfer

Technology transfer at the USDA tracks the following key metrics:

- Licenses/License Income
- Co-op Agreements (including CRADAs)
- Material Transfer Agreements
- Patent Applications Filed
- User Facility Agreements

The following are considered technology transfer from a USDA perspective:

- Information exchange
- MTAs (Material Transfer Agreements)
- Partnership agreements (such as CRADAs and Partnership Intermediary Agreements (PIAs))
- Delivering research results to agencies
- Licensing
- Participating in meetings and conferences
- Distributing info via ARS Info Staff, National Agriculture Library, and other sources

National Aeronautics and Space Administration. Technology transfer has been a requirement for NASA since the 1958 National Aeronautics and Space Act which authorized providing the widest and practical dissemination of its research activities and results and the ability to patent inventions to which it had title. At NASA, the technology transfer policy is centralized at NASA Headquarters. Through the Innovative Partnerships Program, NASA provides a structured, organized approach to technology transfer and carries out the responsibility of sharing their research with the public. NASA IPP helps to facilitate technology transfer through the network of offices located at the 10 NASA field centers.

Key Metrics for NASA Technology Transfer

Technology transfer at the NASA tracks the following key metrics:

- Licenses/License Income
- Software Use Agreements (SUAs)
- Space Act Agreements (SAAs)
- Patent Applications Filed/Patents Issued
- User Facility Agreements
- Invention Disclosures

[10] Howard Bremer and Vic Chavez, "Partnerships to Harness the Innovations and R&D Capacity of ARS for Technology-Based Economic Development" (Presentation), August 19, 2009.

[11] USDA, "U.S. Department of Agriculture Annual Reporting on Technology Transfer FY2009", July 7, 2010.

[12] Ibid

For NASA, the following are key mechanisms for technology transfer:

- Patent License
- Cooperative Agreement (facilitate public purpose activities)
- Software Use Agreement
- Space Act Agreement
- Facilities Use Agreement

Universities

University technology transfer policies were dramatically changed by the passage in 1980 of the Patent and Trademark Act Amendments of 1980, better known as the Bayh-Dole Act in recognition of its co-sponsors, Senators Evan Bayh and Robert Dole. Bayh-Dole created a uniform patent policy among the many Federal agencies that fund research, enabling universities, along with small businesses and other non-profit organizations, to retain title to inventions made under Federally-funded research programs.

Prior to Bayh-Dole, Federal agencies had a scatter-shot approach on how to handle technology transfer. Among the larger Federal agencies funding university research, the Department of Defense prior to Bayh-Dole was allowing universities to retain title to patents resulting from DOD research, provided that DOD retained control of the patents for military application, while both Health Education and Welfare (now HHS) and NSF have negotiated Institutional Patent Agreements (IPA) with individual universities.

The major provisions of the Bayh-Dole Act include:

- Non-profits, including universities, and small businesses may elect to retain title to innovations developed under Federally-funded research programs.
- Universities are encouraged to collaborate with commercial concerns to promote the utilization of inventions arising from Federal funding.
- Universities are expected to file patents on inventions they elect to own.
- Universities are expected to give licensing preference to small businesses.
- The government retains a non-exclusive license to practice the patent throughout the world.
- The government retains march-in rights in cases where the current licensee lacks sufficient commercialization, production or delivery capacity to meet national needs.

The influence of the Bayh-Dole Act went well beyond that of Federally funded research. It spurred universities to participate in technology transfer activities. The Economist has claimed that the Bayh-Dole Act is "perhaps the most inspired piece of legislation to be enacted in America over the past half-century … this unlocked all the inventions and discoveries that had been made in laboratories throughout the United States with the help of taxpayers' money. More than anything, this single policy measure helped to reverse America's precipitous slide into industrial irrelevance."[13]

With passage of the Bayh-Dole Act, the technology transfer activities of U.S. universities have been quite significant. The Association of University Technology Managers reports that in 2007:

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[13] "Innovation's Golden Goose," The Economist, Dec. 12, 2002

- 17,415 invention disclosures from U.S. university researchers were received.
- 10,468 new patent applications were filed by U.S. universities.
- 3,256 patents were issued to U.S. universities.
- 4,316 new licenses and options were executed with industry by U.S. universities.
- 25,109 total active licenses and options were in place with industry by U.S. universities, generating annual fees of $2 billion to U.S. universities.
- 502 start-ups were launched by U.S. university technology transfer offices.

An assessment of the economic impact of licensed, commercialized inventions originating in university research over 1996 to 2007 was prepared for the Biotechnology Industry Organization (BIO) based on AUTM survey data regarding licensing income from all U.S. universities for all technologies. Applying a 5 percent royalty rate, which is a moderately conservative estimate, the BIO study found:

- A total contribution to economic output over 1996 to 2007 from university licensing of technology at $196 billion.
- A total jobs impact over the 12-year period of 279,000 jobs.

Industry

The policy for technology transfer in industry is led by the Federal government for research that they fund and the Federal guidelines discussed previously would provide the guidance for technology transfer. In the private sector, the policy is driven by the parties that are involved in supporting the research activity. It is not often that competitors in the same industry will license to each other unless they have a major need or problem that needs to be resolved in their market. Legal action is one way that players in the same industry may end up working together. Sometimes a group of companies will form a consortium where they agree to cooperate to work together to share the technical/financial risks and their knowledge to jointly promote the technology. The guidelines for participation in the consortium is negotiated upfront where all of the participants agree to share title to the intellectual property developed.

2. Management and Operations

This section discusses internal and external approaches to management and operations of technology transfer.

Internal Management and Operations

For all matters related to DOE technology transfer and commercialization, the Under Secretary for Science is the principal advisor to the Secretary of Energy, while for the DOD these matters are led by the Office of Technology Transition. The contractor's staff operating the DOE and DOD national labs is responsible for technology transfer activities. DOE field-based personnel under the guidance of DOE program officials and the Office of the General Counsel are responsible for direct oversight of the laboratory contractors' technology transfer efforts.

Other Federal agencies such as the USDA, NASA and the DOD have a decentralized structure for the management and operations of technology transfer at their sites. The USDA has five sections in ARS OTT that are used to facilitate technology transfer.[14] NASA has technology transfer offices at its

[14] USDA, "U.S. Department of Agriculture Annual Reporting on Technology Transfer FY2009", July 7, 2010.

various NASA field centers. DOD has over 100 Office of Research and Technology Applications (ORTAs) and related technology transfer focus points.

Among universities, the majority of technology transfer offices are part of the university's research office. In some universities, most notably the University of Wisconsin, the technology transfer function is lodged in an independent nonprofit corporation, which is closely affiliated with the university. The functions of the technology transfer offices nevertheless are similar. Each of the technology transfer offices examined are responsible for reviewing disclosures, identifying technologies with commercial potential, managing the patent process, and licensing technologies. One way in which the technology transfer offices differed is in the extent to which they are involved in negotiating and executing industrial research contracts. Most are involved to some degree in negotiating intellectual property provisions of industry sponsored research contracts.

For industry, the technology transfer office operates internally under a variety of management models. The technology transfer office could be part of the technical or business side of the business. In some businesses, the technology transfer office is a standalone office that has a responsibility for transferring the company's intellectual property to the marketplace. Typically, in most businesses this is not a very large group and many of the technology transfer functions may be the dual responsibility for the internal legal team.

External Management and Operations

External support of their technology transfer management and operations is provided to both DOE and DOD national labs. At the DOE national labs that are managed and operated by universities, the lab collaborates with the universities' tech transfer office to patent technologies and manage IP. For example, NASA Ames managed by Iowa State and SLAC National Accelerator managed by Stanford.[15] At the DOD National labs, the Office of Technology Transition pays for them to form contracts with partnership intermediaries that provide external expertise to supplement the technology transfer staff members' capabilities.

All of the Federal agencies utilize external support to assist with their technology transfer efforts. A few of the agencies, notably USDA and DOD, have established a partnership intermediary program where the agency has authorization to pay for an external group to assist with their technology transfer effort by supplementing the capabilities of the staff. Many of these partnership intermediaries are state and local organization that collaborate with the Federal agencies (see "Government Partnerships" in Appendix A, Section B.2 "T2 Mechanisms – Cooperative R&D"). NASA utilizes a variety of contractors to help research and engage industry in an effort to generate license deal flow and partnerships.

Some universities are also moving their technology transfer operations to a separate, privately managed group outside of the university structure in an effort to create a better relationship between the technology transfer office and the business community. For example, the University of Arizona recently announced in November 2010 that they would do this with their technology transfer office. Their new tech transfer office will be tentatively named the University of Arizona Research Corporation. Another entity, the Arizona Science and Technology Enterprises LLC (AzTE) was established in 2003 as the exclusive technology transfer organization and intellectual property manager for Arizona State University. Georgia Tech is a third example of this with their Georgia Tech Research Corporation (GTRC). GTRC provides research administration, contracting and intellectual

[15] Government Accounting Office, "Clearer Priorities and Greater Use of Innovative Approaches Could Increase the Effectiveness of Technology Transfer at Department of Energy Laboratories", GAO-09-548, June 2009

property management services to the faculty, staff and students of Georgia Tech. As a part of GTRC, the Office of Technology Licensing (OTL) is tasked with managing and protecting the Institute's intellectual property; commercializing these technologies through various contractual mechanisms; protecting the interest of the Institute's researchers; ensuring compliance with government regulations and contractual obligations; and developing and fostering long-term industry relationships.

From an external management and operations standpoint, industry plays a big role in supporting technology transfer instead of being a recipient of these services. Many industry players are specialized by sector and may focus on providing a product or service to technology transfer offices in a specific area. For example, Dawnbreaker is a company that focuses on helping small businesses that are granted SBIRs from the Navy to transfer or transition the technology into the marketplace. Another company, Fuentek LLC, is providing services to NASA as a technology transfer intermediary to help them assess their technologies and determine whether or not they are ready to be transferred to the marketplace. Others provide software products to aid with the management of patents or intellectual property such as Foresight Science & Technology.

3. IP Identification and Protection

At both the DOE and DOD national labs, the contractor has staff located at the national labs that are responsible for identifying protecting the intellectual property created at the facility.

The Federal agencies use a decentralized structure where patent attorneys are located at the respective sites to provide intellectual property protection or to provide oversight to the contractor managing and operating their national labs.

For universities, as mentioned earlier, since the passage of the Bayh-Dole Act, technology transfer offices have been established to elicit disclosures from faculty, determine patentability and selectively pursue patents through their technology transfer and licensing offices. Such offices often select which patents to pursue based upon identified industrial partners expressing an interest and financial commitment to advance the subject technology to the market.

What most significantly underpins the work of the technology transfer office in IP identification and protection is the receptivity of researchers to get involved in commercializing their research discoveries. There is a tension that typically is found within academic and non-profit research institutions between undertaking research to advance basic knowledge and harvesting that research to pursue private, economic gain through technology commercialization. Whether researchers are inclined to be receptive to technology commercialization is a personal decision, but one that is strongly influenced by the orientation of an institution towards technology commercialization as demonstrated by its leadership and research peers. It also relates to the specific rules set out by the research institution, including:

- How the researcher is compensated for the commercialization of their research efforts. Is there sufficient incentive to the researcher? Can they get rich if their research discovery garners a large commercial market?
- How the researcher's tenure and other career advancement prospects within the research institution will be affected by spending time involved with technology commercialization. Many research institutions view time spent on technology commercialization as time lost for basic research and teaching resulting in a demerit towards tenure and career promotion.

Most importantly for technology transfer is that words and actions must go hand-in-hand, especially for institutions that are attempting to revamp dormant technology commercialization efforts. The recent efforts to upgrade the University of Massachusetts' technology transfer system in the late 1990's illustrate how words and actions can be effectively orchestrated.

- The state legislature passed a special exemption in state law removing the University system from state ethics restrictions and authorizing the establishment of a university-driven approach.
- The new University system President expressed strong support for technology transfer through presidential decrees and press conferences on technology transfer activity, and made economic development part of the university's core mission.
- In negotiations with faculty, the University administration won reforms for tenure criteria to indicate the importance of technology transfer and industry collaboration and to focus on commercialization track record for recruitment of key faculty.
- The University administration created a new position of Vice President of Economic Development to focus the overall University's efforts to enhance the economic health of the state.
- Established a new technology transfer office lead by a former entrepreneur and venture capitalist in what has become the Commercial Ventures and Intellectual Property office.
- Created a $500,000 patent fund and established seed funding for projects with promising commercial potential with licensing proceeds.
- In terms of sharing revenues and proceeds from technology transfer, a progressive royalty sharing arrangement would be 30 to 50% of net royalties going to the faculty member.

Industry's IP identification and protection can vary widely depending upon the business model being used.

A few of the notable approaches that were found during the literature search for IP identification and protection are the following:

Table A-1: Approaches for IP Identification and Protection

Industry Sector	IP Identification and Protection Example(s)
National Labs	
DOE	❖ Innovation Bundling Agreement – This idea was developed by Technology Ventures Corporation, TVC, (a nonprofit foundation) where patents originating from Los Alamos National Laboratory, Sandia National Laboratories, Lawrence Livermore National Laboratory and the Nevada Test Site are sorted or bundled into groups and similar technologies so they can be more easily marketed to the private sector.[16] ❖ IP Evaluation of Pending Publications – Lawrence Livermore National Lab – T2 staff regularly evaluates pending research publications from the lab for evidence of technologies or inventions that have not been disclosed or market opportunities that have been overlooked.
Federal Agency	
DOD	❖ Patents are reviewed by legal counsel located at each agency site with licensing managed by the technology transfer office at the respective site.
USDA	❖ Patent Review Committee (PRC) – "The Patent Review Committee (PRC) is an important and confidential part, of the ARS patent process. It is composed of a PA (Patent Advisor) and several scientists as peers. Individual scientists are invited to serve as voting members because of their scientific expertise. Others, such as the TTCs (Technology Transfer Coordinators), other members of OTT, and National Program Leaders of National Program Staff, often sit in and contribute to the discussion, but are generally nonvoting members. PRCs are established by PAs for their geographic region of responsibility, or by subject matter area, such as biotechnology or mechanical/chemical inventions."[17]
NASA	❖ At each NASA Center, the patent licensing function is managed by the Center's Innovative Partnerships Program Office with the advice and counsel of the Center's patent counsel.
Universities	❖ 18 prominent U.S. and international universities that conduct a high level of biological/medical research have agreed to a use a simplified materials use agreement for handling the exchange of biological materials. The agreement, recommended by NIH, is referred to as the Uniform Biological Material Transfer Agreement.[18]

B. T2 Mechanisms

This section discusses six categories of T2 mechanisms: licensing, cooperative R&D, technical assistance, information exchanges, public sector technology transfer, and other T2 mechanisms.

1. Licensing

Both the DOE and DOD national labs initiate nonexclusive or exclusive license agreements for intellectual property that has been patented, copyrighted, or trademarked. Typically, in these license agreements, the licensee agrees to pay a fee for royalties to the lab in exchange for rights to the use

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[16] "Patent Pooling," Innovation Magazine, October/November 2007. Retrieved from http://www.innovation-america.org/patent-pooling

[17] "Technology Transfer in ARS – Policies and Procedures", USDA, September 2000

[18] Material Transfer Agreements", Stanford University, September 18, 2009. Retrieved from http://www.stanford.edu/group/ICO/researcher/documents/MTA9-18-09_000.pdf

or commercialize the IP. Companies of all sizes from small to large corporations may license intellectual property from the national labs. Due to the high risk and the investment that is involved with transferring a technology into the marketplace and to support the economic development in their region, many of these labs have created programs to help initiate or support start-up companies or entrepreneurs near their facility.

At the Federal agencies universities, and industry, licenses are typically pursued to transfer technology to the private and the public sector.

The following provides some examples of technology transfer best practice approaches in the area of licensing:

License Agreements

One of the major issues that national labs face is that the contractor must get the sponsoring agency to approve any licensing agreement and it must contain certain terms and conditions required by Federal law and policy of the sponsoring agency, which often lengthens the negotiating process or discourages the potential licensee. Therefore, national labs are taking steps to improve this process.

Federal agencies are also impacted by Federal law and their policies where its licenses must contain certain terms and conditions. They have established new types of licensing agreements and developing new methods to help improve the licensing process and find prospective licensees. The USDA and DOD have created licensing agreements that will allow the agency to transfer more of its intellectual property to industry, while NASA is reaching out to its scientists to help it find potential licensees for its intellectual property.

Universities often bring an orientation to either license technologies or to focus on start-up companies. According to FY2008 AUTM survey, universities executed 5,039 total licenses and options and had launched 3,381 startup companies that are still in operation at the end of FY2008 based upon university technology.

Another way in which technology transfer offices differ is the extent to which they focus on licensing only the most promising technologies or working to license as many technologies as possible. The Wisconsin Alumni Research Foundation (WARF) and the Washington Research Foundation (WRF) exemplify this difference in approach. WARF, an independent public corporation, was established in 1925 to commercialize technology developed at the University of Wisconsin-Madison. Since that time, WARF has obtained more than 1,900 patents and 1,500 foreign equivalents and returned more than $1.07 billion to the university to support research and ongoing technology transfer activities. The WRF was established in 1981 to license university technology. WRF was very selective in choosing technologies to license and several technologies licensed were very successful. Then in the late 1990s, WRF decided to shift its focus from licensing to creating new start-up companies. Revenues from its earlier licenses were used to create a seed fund.

Industry will often license patented technology that is no longer part of their core businesses or technologies that have not been used and commercialized. In this challenging economic development environment, many more technical companies are now looking much more closely at their technology portfolio to see if there are opportunities to benefit the business by licensing technology this is not in use. Industry is also looking outside of their organization to license technologies back into their organization that will fit their core business. For example, Proctor & Gamble (P&G) has established a program called “Connect and Develop” that allow companies to submit a non-proprietary description of their technology and P&G will select the best technologies from outside firms to negotiate a license agreement. Lastly, industry may cross license technologies to give each entity rights to the other to utilize the technology that they have developed. This is often done in industries that produce products with complex systems such as semiconductors and electronics.

Table A-2: Licensing Agreement Examples

Industry Sector	Example(s) of Licensing Agreement or Method
National Labs	
DOE	❖ Online Licenses – Allows Sandia employees to leave the lab to start-up a company or support a small business with an option to return to their position at the lab after a 2 year period[19]. ❖ Standardize License Agreements – Various labs are providing license agreements with preapproved terms and conditions by DOE to speed up the licensing process.
Federal Agency	
DOD	❖ Software Usage Agreements – Used as an instrument by DOD to give commercial partners an option to test software before licensing – this is accomplished by tailoring a CRADA to allow a commercial partner to provide funding to the DOD for limited use of this technology and gives the commercial partner an opportunity to work with the DOD in increasing the commercial potential of the software.
USDA	❖ Standard Material Transfer Agreement – ARS-OTT collaborated with the governing body of the International Treaty on Plant Genetic Resources for Food and Agriculture to develop a SMTA for the transfer of wild plant germplasm that allows access across the world for member countries.
NASA	❖ Leveraging NASA Scientists' Contacts with Industry – Technologists at the NASA field centers are used to help identify and find potential partners and licensees through their relationships with peers in the private and public sector.
Universities	❖ Exclusive and non-exclusive/field of use licenses – both are executed by universities. ❖ "Socially responsible licensing" – Some universities adopt a guiding value for their licensing which recommends consideration of provisions that address unmet needs, giving particular attention to improved therapeutics, diagnostics and agricultural technologies for the developing world. ➢ Some universities forego the filing of patent applications in developing countries and/or waive royalties for sales of health-related technologies in developing countries.
Industry	❖ Intellectual Ventures – aggregator of invention portfolios from organizations that they license to the marketplace ❖ Proctor and Gamble – Its "Connect and Develop" initiative, reflects the fact the over 50% of P&G's new products involve significant collaborations with outside parties. ➢ P&G's "Connect and Develop" strategy has resulted in more than 1,000 active agreements. ❖ Cross-licensing ➢ Intel-AMD has a cross-licensing agreement in place that allows the companies to use the patented technology developed by the other organization.

[19] Chris Burroughs, "A Boon to Sandia Entrepreneurs", Innovation Magazine, December 2008/January 2009, http://www.innovation-america.org/boon-sandia-entrepreneurs

Start-ups (or Spin-offs)

One of the biggest challenges for technology transfer staff is finding entrepreneurs who are interested in starting up a company based upon their intellectual property. Two different approaches emerged from our research in this area – 1) internal start-up approach and 2) external start-up approach. For example, the internal start-up approach, the organization will utilize its internal staff to assist or provide help for start-up companies based upon its intellectual property, while for the external start-up approach, the organization will seek to collaborate with external business support services or entrepreneurs to help form small businesses based upon its technology.

One approach is where the national labs such as Sandia, Lawrence Livermore and Oak Ridge National Labs have decided to look internally for entrepreneurs, while for the other approach, the labs (Lawrence Livermore and Sandia) have decided to look externally.

Among universities, there have been considerable advances in how to support start-up companies. One innovative approach is that of the Georgia Research Alliance's (GRA) Venture Labs Program. Under the Venture Labs program, a VentureLab manager is funded by the GRA at each participating campus. These VentureLab managers recruit and oversee the efforts of serial entrepreneurs who assist in identifying and assessing technologies that can support a start-up venture. GRA then provides a competitive-based pool of funding for further assessment of commercialization potential over a three phase process:

- Up to $50k grant → Is the technology commercially feasible to support a new company?
- Up to $100k matching grant → Prototype development – matching funds to validate in the marketplace required
- Up to $250k loan → Executed license + management team in place

The results of GRA's VentureLab program have been considerable. From 2002-2008, GRA expended $17 million, which resulted in 500+ university inventions or discoveries evaluated, 100+ active companies formed with 500+ employment and $350 million in equity investments raised.

Another innovation in start-up activity focuses on simplifying the process of accessing university technology. The Carolina Express License Agreement was developed by a committee of University of North Carolina (UNC) faculty entrepreneurs, venture capitalists, attorneys and UNC's Office of Technology Development as a way to shorten the cycle time in which Federally funded inventions move from lab to market. Founders or entrepreneurs interested in starting a company can choose the Express License, which outlines provisions for company ownership, future revenue payments and other common sticking points that can slow down commercialization. Under the Bayh-Dole Act, universities own rights to intellectual property generated by their faculty. By creating a standardized licensing agreement, UNC departs from current commercialization guidelines issued by the Association of American Universities, which states that all technologies arise under unique circumstances and therefore require a customized licensing process.

The following provides examples of these two different technology transfer approaches that other industries are taking to help in the formation of start-up companies:

- Internal Approach – Using internal resource to help form start-up companies

Table A-3: Internal Start-Up Approaches

Industry Sector	Internal Start-Up Approach
National Labs	
DOE	❖ Entrepreneurial Separation to Transfer Technology (ESTT) program – Allows Sandia employees to leave the lab to start-up a company or support a small business with an option to return to their position at the lab after a 2 year period[20].
Universities	❖ Universities allow the start-up of companies by faculty and students based upon IP developed at the university while adhering to strict policies and guidelines to avoid conflict of interest. ❖ Most universities now have entrepreneurship courses, programs, and centers to encourage and support start-up ventures. Example: MIT Entrepreneurship Center, Stanford's Technology Ventures Program, and Penn State's Center for Engineering Design and Entrepreneurship.
Industry	❖ Internal innovation works or skunk works – These internal groups been established in industry to advanced technology development within more flexible, entrepreneurial structures. Recent examples include Boeing's Phantom Works and Sikorsky Innovations. Such units also tend to be more open and accessible to external sources of technology and innovation.

- External Approach – The organization engages with entrepreneurs to help form start-up companies

Table A-4: External Start-Up Approaches

Industry Sector	External Start-Up Approach
National Labs	
DOE	❖ Venture Accelerator Program – Engages entrepreneurs, investors and subject matter experts to help select and form companies involving Lawrence Livermore National Lab. ❖ Technology Venture Corporation – A nonprofit corporation founded by Lockheed Martin (operator of Sandia) in 1993 that focuses on technology transfer and commercialization from primarily Sandia national lab and research universities in the region.
Federal Agency	
DOD	❖ Incubators ➢ Picatinny Technology Innovation Center at the Picatinny Arsenal – Nurtures companies (including some start-up companies) that develop technologies that the Army is interested in using or being developed by the Army.
Universities	❖ Innovation Park at Penn State – A 118-acre business park that provides companies with multiple real estate options, an incubator program, and business support services. Residents of the Park have access to Penn State resources and the support services to transfer knowledge from the University to the marketplace. ❖ The Deshpande Center at the MIT School of Engineering – Established in 2002 to increase the impact of MIT technologies in the marketplace. ➢ Since 2002, The Deshpande Center has funded more than 80 projects with over $9 M in grants. ➢ 18 projects have spun out of the center into commercial ventures, having collectively raised over $140 M in outside financing. Thirteen venture capital firms have invested in these ventures.
Industry	• Corporate venture capital arms occasionally used for this purpose.

[20] Chris Burroughs, "A Boon to Sandia Entrepreneurs"

Both the DOE and the DOD national labs and some of the other Federal agencies such as NSF and USDA participate in the Small Business Innovation Research and the Small Business Technology Transfer program that provides funding to small businesses that develop and commercialize technology that meets a specified need of the sponsoring agency. These programs also facilitate the transfer of technology by small business.

2. Cooperative R&D

A second technology transfer mechanism that is utilized by the DOE and DOD national labs is cooperative R&D between the lab and the private sector/universities or the lab and multiple firms. DOE and DOD national labs enter into cooperative research and development agreements for this type of R&D. Technology transfer is facilitated by cooperative R&D because the intellectual property that is generated as part of the CRADA may be granted to the company in advance by the lab director.

Cooperative agreements are also developed between the Federal agencies and industry for collaborative research efforts and to help transfer the technology developed to the private sector. CRADAs are typically negotiated and implemented at the respective sites for the Federal agencies. NASA is the one agency that does not really use the CRADA for collaborative research, since they utilize the Space Act agreement as their primary means to help foster joint research between NASA and the private or public sector. Similar to the national labs, the Federal agencies can grant the intellectual property to the company that is party to the CRADA.

Universities form cooperative agreements with industry and the Federal government to perform joint research efforts that can involve technology transfer. Typically, for university-industry collaborative agreements, the university will grant full rights to the intellectual property if the industry partner pays for the full cost of the research. In those cases where the industry partner pays for part of the cost, then they may grant partial rights or nonexclusive rights to the intellectual property resulting from a cooperative agreement. For joint university-Federal government research, the university is typically granted title to the IP based upon Federal policy.

In addition to forming collaborative agreements with universities and the Federal government, industry may establish joint research efforts among others in private industry or non-profit institutions. Typically, these collaborative agreements are formed when industry members or a company and a non-profit decide to share their know-how (i.e. their skills and resources) to solve a particular problem occurring in their industry.

The following are some of the technology transfer best practice approaches for Cooperative R&D:

CRADAs and Cooperative Research Agreements

Similar to licensing agreements, one of the major issues with CRADAs at the national labs is that these agreements take a long time to negotiate because they must be approved by the sponsoring agency. Both the DOE and DOD national labs have initiated efforts to develop special agreements to improve the CRADA process and make it more efficient.

Federal agencies share a similar focus with the national labs where they are looking at ways to improve the negotiation process for CRADAs and Space Act agreements and easily allow the transfer of the technology to occur.

Among universities, a key mechanism for advancing collaborative research between industry and universities is to provide matching grant funding for applied research projects. Such projects help build relationships between researchers and companies and provide support for activities that help to move technology to the point where private investment capital can be obtained.

As of 2008, twenty-eight (28) states, either through a state technology development agency or a university system, have matching grant programs that provide an incentive for firms to support research projects at local colleges and universities. Two of the longest standing such efforts are the Maryland Industrial Partnerships program operated through the University of Maryland and the University of California's Discovery Grant program. Most of these programs solicit applications on a competitive basis and make awards to projects that are both technically sound and likely to have a positive economic development impact. All of the programs require the company to share the cost of the research project, which is conducted by faculty and students on behalf of the company. The level of cost share can vary. Some programs vary the matching requirement based on the size of the company.

Industry will primarily transfer its technology on a cooperative research basis through the formation of consortiums. These consortiums are strategic research alliances where organizations agree to collaborate on research to solve a complex problem or issue in their area. Technology transfer occurs through the sharing of knowledge, publications, and research that is produced through the consortium. Examples of these consortia include the Electric Power Research Institute (EPRI) or the Semiconductor Manufacturing Technologies (SEMATECH).

Table A-5: Cooperative Research Examples

Industry Sector	Cooperative Research Example(s)
National Labs	
DOE	❖ Model CRADAs ➢ Savannah River National Lab – Developed a "model" CRADA for cooperative research projects with universities in S. Carolina[21]. ❖ "Umbrella" CRADAs ➢ Sandia and Los Alamos National Lab – Standardized agreements with major companies (such as Chevron or Goodyear) where the national lab has an ongoing partnership and entered into multiple agreements.
Federal Agency	
DOD	❖ Standard templates ➢ Air Force and Navy have established standard templates.
USDA	❖ USDA CRADAs – ARS is required to keep confidential indefinitely any proprietary information given to ARS directly by the cooperator, unless the information becomes publicly available from a source other than ARS. ➢ It gives the cooperator the right to negotiate an exclusive license in at least one field of use to any ARS solely owned invention(s) or jointly-owned invention(s) conceived or reduced to practice under the scope of work of the CRADA. ➢ Second, it permits ARS, at its option, to keep information developed under the CRADA confidential for up to five (5) years if such information would have been proprietary had it been generated solely by the cooperator.
Universities	❖ Sponsored research agreements ❖ Material transfer agreements ❖ Collaboration agreements ❖ Equipment loan agreements
Industry	❖ Research Consortia ➢ SEMATECH ➢ EPRI

[21] Chris Burroughs, "A Boon to Sandia Entrepreneurs"

Government Partnership Programs

Government partnership programs are another way that technology transfer occurs at the national labs and Federal agencies. These programs could be government-industry or inter-agency government partnerships. The focus of these programs is typically a specific technology area or mission area of the national lab or Federal agency where the partners can cooperatively work together to share the financial and technical risks on R&D. For some of these partnerships, this may involve the government transferring their technology to the partner for their use or in other cases it may involve the partner transferring their technology back to the Federal government to meet their needs.

The following are some examples of government partnership programs that have been formed to help foster technology transfer:

Table A-6: Examples of Government Partnership Programs

Industry Sector	Government Partnership Programs
National Labs	
DOE	❖ Solid State Lighting (SSL) Program[22] ➢ Core Technology Program (including universities, National Laboratories) that negotiates only with SSL Partners (who are providing substantial cost share) for non-exclusive, royalty-bearing license in a field of use for 1 year after patent issues. (If no agreement after 9 months of negotiations, SSL Partner can go to court to force licensing on reasonable terms). ❖ Entrepreneur-in-Residence ➢ Office of Energy Efficiency and Renewable Energy at the Department of Energy brought entrepreneurs sponsored by VC (venture capital) firms into three DOE labs (NREL, ORNL and Sandia) to help develop plans to commercialize new clean energy technology and identify technologies with the best market potential[23].
Federal Agency	
DOD	❖ Cooperative Agreements ➢ Establishing partnerships to transfer Federal agency technology to create new military and commercial products into industry. ➢ Partnerships to transfer technology from industry back to the Federal agency to meet their needs.
USDA	❖ USDA-NASA Inter-Agency Partnership ➢ Memorandum of Understanding (MOU) was formed between ARS and NASA in the area of space-related biological and environmental.
NASA	❖ Centennial Challenges ➢ Prize contests to stimulate competition and innovation in NASA mission areas. ❖ IPP Seed Fund ➢ Cost shared, joint partnerships established annually to address technology barriers at NASA.

[22] Argonne National Lab Presentation, "University Lab Partnerships", 2009

[23] Tom Michael, "A Tech Push at the Energy Department", Innovation America, February/March 2008, http://www.innovation-america.org/archive/february-march-2008

3. Technical Assistance

A third way that technology transfer is facilitated through the DOE and DOD national labs and the other Federal agencies is through the technical assistance that they provide to private sector, universities and other entities. The national labs and Federal agencies possess unique equipment resources and expertise at their facilities that can help resolve a research problem or issue. Some of these programs that offer external access to Federal equipment or expertise can be free of charge a fee for the service. Typically, the national labs and Federal agencies offer the access to the equipment at their facilities through user agreements or commercial test agreements, while work for others agreements allow the national labs to share their external expertise with other entities.

Among universities, there are many that offer centralized industrial liaison efforts to engage industry and connect them with university resources. One of the oldest and best-elaborated programs in the nation is MIT's Industrial Liaison Program (ILP). It dates back to 1948, when an alumnus became frustrated at an inability to connect his company efficiently with the technical resources that he knew were at MIT. He recruited an initial group of corporations that he knew would be willing to pay for the ability to reach into the university and always find the right resource. Today, the ILP is a fee-for-service operation that employs over a dozen industrial liaisons and many support staff involved in research, event planning and access to information databases. Members range from the largest global enterprises to smaller, high-technology businesses in and out of the New England region. Each company joining the ILP gains special access to information about research and technology at MIT – although no favored position with respect to research or licensing terms. Membership fees pay in part for assignment of an ILP staffer as a "Liaison Officer" – a long-term relationship manager who identifies the needs of the member and ensures that all desired services are delivered, or at least proposed if they are at extra cost.

Industry will primarily look at their internal resources to provide technical assistance. When companies do look outside the organization, they will either bring in the talent as a consultant (from academia, national lab, or a specialized area in industry) or interns and co-operative education students to provide knowledge and expertise to the organization. Another method by which firms seek technical assistance is by negotiating deals through industry sponsored research agreements or other master agreements where they get first right of refusal to the intellectual property being developed using their respective facilities or equipment.

The following provides some technology transfer best practice examples for technical assistance at the national labs:

User Agreements

The user agreements are executed by national labs to allow the external (and sometimes internal) entities to pay to use their special facilities for R&D. Depending upon the arrangement – nonproprietary versus proprietary – the user may retain title to the technical data and inventions created.

Federal agencies also offer similar types of agreements for the use of their special facilities and equipment to the private sector. In addition, some of the Federal agencies offer fee for service use of their equipment, or facilities for testing by external entities through the use of commercial test agreements.

Universities are actively engaged in industry contract research as well as offering access for shared use equipment and facilities. Typically, the engagement of universities in industry contract or "sponsored" research and accessing shared use labs is handled at the faculty, research center or departmental level. The only university-wide involvement is in overseeing the contracting process, particularly ensuring IP and indemnification clauses are in place, and in addressing policies such as prohibiting routine testing, managing conflict of interest policies, or competing with the private sector. More seamless use of facilities is typically advanced in universities through research centers that have developed core facilities that are made available to industry affiliates to the research centers. For example, the University of Connecticut's Institute of Material Sciences has a suite of characterization, testing and prototyping facilities available to their industry affiliates. Federal funding in nanotechnology has also put in place a network of shared use facilities across the nation, and nearly all Engineering Research Centers funded by NSF have developed shared use facilities available to their industry affiliates. In terms of innovations, Penn State has put in place a standardized master agreement approach to get beyond fragmented, short term industry relationships and promote more long-term, university-wide, multi-disciplinary partnerships with industry. The master agreement means that both the company and the university agree in principle on a number of issues. For each individual project, the company and university agree on which options should be applied. Prior to establishing a master agreement, Penn State staff work closely with the company to understand their needs. Penn State currently has more than two hundred master agreements in place.

Industrial firms often form relationships with individual faculty and researchers or organizations that perform research in the area of interest and will often support their work by supplying or providing free access to their equipment and facilities in exchange for first right of refusal to any intellectual property or access to research publications that is generated as a result of this support.

The following are some examples of how the national labs and Federal agencies have executed user agreements to help technology transfer:

Table A-7: User Agreement Approaches

Industry Sector	User Agreement Approaches
National Labs	
DOE	❖ Non-proprietary User Agreement for All DOE User Facilities ➢ User pays its own costs of the research with the DOE laboratory, may access specialized laboratory equipment and collaborate with laboratory scientists. ➢ Non-proprietary user and the national laboratory retain title to their own inventions and research data generated under non-proprietary research is made public. ❖ Proprietary User Agreement for DOE User Facilities ➢ User pays the full cost up to $50,000 for use of specialized laboratory equipment. ➢ With limited exceptions, retains all proprietary and technical data generated, as well as the rights to any new inventions.
Federal Agency	
DOD	❖ Enhanced Use Agreements ➢ Allows DOD to lease their property ❖ Commercial Test Agreement ➢ ARDEC CRADA Process – Teaming between industry partners and Federal agencies to access to the US Army Armament Research Development and Engineering Center (ARDEC) expertise and unique capabilities to support military systems development.
USDA	❖ Enhanced Use Lease (EUL) Activities ➢ The Food, Conservation, and Energy Act of 2008 gave the ARS authority to start EUL activities at the Henry A. Wallace Beltsville Agricultural Center (BARC). Tenants at BARC would be required to develop a license agreement to commercialize ARS research with patentable IP or establish formal research partnerships with ARS researchers.
NASA	❖ Enhanced Use Lease Agreement ➢ Allows NASA to lease property assets that may not be fully utilized.
Universities	❖ Some universities allow use of their facilities for the following situations: ➢ In exchange for cash or equity from start-up companies ➢ During idle times companies are charged a fee to utilize their lab or test facilities.
Industry	❖ Companies making their excess capacity or equipment available to outside entities in consideration for access to research publications or first right of refusal on the intellectual property generated from usage.

Work for Others

The national labs or Federal agencies may provide technical assistance to transfer their knowledge to the public or private sector either on a fee for service basis through formal programs or for free through informal channels. Work for others is a formal method where the national lab can allow its technical resources to solve problems for the external organizations as well as other Federal agencies. By allowing its personnel to work with the private sector or other Federal agencies to resolve issues on a fee for service basis, the national labs are transferring their technical expertise. Many of the Federal agencies allow their technical staff to provide a minimum amount of free assistance that varies by agency to help another organization resolve a technical problem or issue.

Universities typically do not offer organized technical assistance programs, but many faculty provide fee-based or free consulting to help resolve R&D issues. A notable exception to this is the PennTAP program established by Penn State in 1964. In addition, at many universities, the students (i.e. graduate and doctorate students) may individually or through class projects provide free consulting to help the public and private sector with technical issues.

Industry typically provides technical assistance to an organization on a fee for service basis. These arrangements vary depending upon the agreement between the respective organizations. Industry may also work with universities, Federal agencies and national labs where they may form staff exchange programs, in which personnel from these entities can work at a firm or vice versa. The technology transfer occurs by the researcher from the university, Federal agency or national lab learning more about developing a product, while the firm may gain more knowledge about the research that is being conducted in a particular technical area.

The following are some best practice examples of how other industries are conducting technical assistance to help facilitate technology transfer:

Table A-8: Technical Assistance Examples

Industry Sector	Technical Assistance Example(s)
National Labs	
DOE	❖ Non-Federal WFO (business using national lab expertise) ➢ A private company received funding from the DOE to work with National Energy Technology Lab (NETL) to create and test a more energy-efficient method for drying coal ❖ Federal WFO (another Federal agency using national lab expertise) ➢ Pacific Northwest Laboratory (PNNL) received funded work from the Department of Homeland Security to leverage the lab's expertise in radiation detection to develop passenger and cargo screening technology[24] ➢ Argonne National Laboratory created a system for the US Dept. of Transportation to detect and respond to chemical attacks in confined, populated spaces such as subway tunnels[25]
Federal Agency	
DOD	❖ Standard templates ➢ Air Force and Navy have established standard templates
Universities	❖ Consulting ➢ Faculty consulting ➢ Student consulting
Industry	❖ Consulting ❖ Staff exchange programs

[24] Government Accounting Office, "Clearer Priorities and Greater Use of Innovative Approaches Could Increase the Effectiveness of Technology Transfer at Department of Energy Laboratories", GAO-09-548

[25] Ibid

4. Information Exchanges

The fourth mechanism that best practice technology transfer approaches are appearing in the industry sectors is through information exchanges. Technology transfer occurs through this method when the technical information that is available at the national lab, Federal agency or university is transferred to the private sector or transferred from the private sector to the national lab, Federal agency, or university. This activity may happen either through a formal exchange of this information such as website, or an informal exchange of information such as conferences or seminars. These information exchanges differ from the technical assistance efforts because the information is made available for many users and not customized.

The following are examples of technology transfer best practices in other industries involving information exchanges:

Formal

Formal information exchanges are occurring in other industries to help facilitate technology transfer through a number of channels. Some of the approaches are in settings where organizations make formal arrangements for their technical experts to interact with the private sector face-to-face, or in other instances they are marketing their technology to the private sector using electronic media such as an Internet site. Others are using a combination of face-to-face meetings and electronic media through the use of intellectual property auctions to help transfer their technology to potential licensees.

Table A-9: Formal Information Exchanges

Industry Sector	Formal Information Exchange Example(s)
National Labs	
DOE	❖ Technology Commercialization Portal ➢ The US DOE's Office of Energy Efficiency and Renewable Energy has created an internet portal site with 200 marketing summaries that are available to those entities seeking cutting-edge energy efficiency and renewable energy technologies for licensing. ❖ IP Auctions ➢ Lawrence Livermore National Lab is making available valuable inventions to potential licensees.
Federal Agency	
DOD	❖ Office of Technology Transition Web-based tool ➢ Searchable web-based tool that enables the Defense labs to present their available technologies in a single location. ❖ DOD Websites ➢ Technology transfer websites are maintained by each of the military services, defense agencies and the Office of the Secretary of Defense to inform the public and make information available such as: ▪ Contacts for ORTA technology transfer opportunities ▪ Training ▪ Success stories ▪ Examples of mechanisms and agreements to facilitate cooperative research and technology transfer to the private sector
USDA	❖ Web based modules ➢ Two new modules in development to provide slide shows of ARS outcomes and licensed products. ➢ One new module in development to provide the enhanced search ability for visitors to go through their new patent portfolio of available technologies. ❖ ARS-OTT Technology Alerts ➢ Provides specific targeted information to potential and current agency customers. ❖ ARS Technology Transfer Workshops ➢ OTT in conjunction with National Programs Leaders from the Office of National Programs conducted a workshop in FY2009 focused on the technology transfer processes needed to enhance crop protection and quarantine research outcomes.
NASA	❖ Marketing publications ➢ Tech Briefs ▪ Monthly publication that lists NASA licensing opportunities available. ➢ Spinoff ▪ Publication that highlights the transfer of NASA technology to the private sector. ▪ Available in print, online via a dedicated website, and as an interactive CD. ▪ Searchable database of stores is available on the website. ▪ The total number of stories published since Spinoff was first published in 1976 is over 1,600. ❖ Auctioning IP ➢ Five software code patents are planned to be auctioned as part of an exclusive license by Ocean Tomo for NASA Goddard Research Center.

Table A-9: Formal Information Exchanges (Continued)

Industry Sector	Formal Information Exchange Example(s)
Universities	❖ iBridge Network • Online portal site where universities can list their available technologies.
Industry	❖ Establishment of key points of contact within the company, whose mission is to interface with prospective technology developers, etc. ❖ Firms are increasingly using social media and the internet to solicit and filter opportunities in both directions (in and out-licensing, etc.)

Informal

Informal information exchanges that take place in other industries such as national labs, Federal agencies, universities and industry are often a challenge to track from a metrics standpoint. Most of these informal exchanges occur as a result of the staff interacting externally with the private sector at various events or publishing their technical results. These interactions could lead to the transfer of knowledge that could be used to eventually solve a technical issue.

The following are some examples of how the national labs are using informal information exchanges for technology transfer:

Table A-10: Informal Information Exchanges

Industry Sector	Informal Information Exchange Example(s)
National Labs	
DOE	❖ Publications ❖ Conferences
Federal Agency	
DOD	❖ Technology Forums ➢ Principal Investigators (PIs) often showcase DOD inventions at these forums.
USDA	❖ Tradeshow attendance ➢ Part of the ARS OTT marketing strategy to diversify and reach new target customers.
NASA	❖ TecFusion Forum ➢ Allows large companies in various industries to get their needs met by technologies developed by small businesses through Federal funding. ❖ NASA is creating a Participatory Exploration Office to infuse more public participation into NASA's mission.
Universities	❖ Publications ❖ Conferences
Industry	❖ Professional and Technical societies ➢ Interactions occur through work performed on national and international standards, quality and other pre-competitive issues and opportunities.

5. Public Sector Technology Transfer

The fifth way that technology transfer is being conducted at the national labs and Federal agencies is through the public sector. Many of the national labs and Federal agencies are able to transfer their knowledge or technology to state and local (S&L) personnel either by using their know-how or helping to assist student and faculty in science and math areas. They also use their technical expertise to work collaboratively with S&L organizations to implement technical solutions and to provide external support for their technology transfer staff.

Public Sector Assistance

Some of the national labs or Federal agencies have established a formal program where they allow their staff to provide free assistance to state and local personnel to help transfer their technology or expertise into the public sector. Many of these efforts are focused in the regions where the national lab or Federal agency is located. In addition, the Intergovernmental Personnel Transfer Act allows temporary assignment of Federal agency personnel to provide their expertise to state and local government.

Collaborations with the Public Sectors

The national labs, Federal agencies and universities are also collaborating with state and local groups to help transfer their technology into the public sector. The national labs and Federal agencies are working with partnership intermediaries who are in many instances state and local groups to help them extend their technology transfer staff capabilities through some of the following activities:

- Marketing outreach (i.e. market technology)
- Pursue leads (i.e. interface with potential licensees)
- Market research

At the state level, university-industry research centers were the key centerpiece of early technology-based economic development programs in Kansas, New Jersey, New York, and Ohio. Many, if not most, of the centers created under these programs still operate today, some with continuing state support and some with alternative sources of funding but these programs have evolved significantly. Interest in university-industry research centers waned somewhat in the 1990s due in part to concerns that the centers were too dominated by academic interests and as a result were not having the economic development impact that was desired.

Today, with the growing recognition of the need to promote multi-institutional, multi-disciplinary research, interest in centers programs is again high. The Ohio Third Frontier with its nationally acclaimed Wright Centers are an excellent example of how states are leveraging multiple universities to create broader partnership efforts with industry focused on moving technology into the marketplace. Even smaller, less research intensive states are pursuing university-industry research centers. For instance, South Dakota funded three Centers of Excellence in 2004 and the North Dakota legislature committed $50 million to create Centers of Excellence at the state's universities and colleges in 2005.

Another leading state technology development program, Maryland's Technology Development Corporation (TEDCO) has distinguished itself as a leading intermediary that facilitates collaborations and technology transfer between Federal laboratories and small businesses on behalf of the state of Maryland and others. TEDCO connects emerging technology companies with Federal laboratories, research universities, business incubators and specialized technical assistance.

An Economic Development Administration report notes that the design of a university-industry research center, however, can vary significantly depending on the specific objective that a state or region is trying to achieve. Traditionally, university research was conducted by individual investigators housed in discipline-focused departments. Within the past twenty years, however, an increasing share of the growth in university research is channeled through research centers or institutes. A research center generally includes a number of affiliated faculty members, a center director and management, graduate students, dedicated laboratory facilities, allied educational programs and, in the case of university-industry centers, industrial partners. More and more, such centers also include commercialization activities. Industry-university research centers can be organized in several ways. They can be part of the university; they can be independent but closely affiliated with a university; or, they can operate as a completely independent nonprofit organization. There are advantages and disadvantages to each approach. Centers that are part of the university have to make sure that they understand and are responsive to industry needs. Likewise independent nonprofits must understand and appreciate the academic climate in which university researchers must operate. A successful center is one in which the Center is able to bridge the gap between two very different cultures, academia and business.

The following are some examples of collaborations by other industries with the public sector:

Table A-11: Public Sector Collaborations

Industry Sector	Example(s)of Collaborations with the Public Sector
National Labs	
DOE	❖ Sandia National Lab and PNNL Economic Development Programs ➢ Lab personnel provide technical advice to local small businesses.
Federal Agency	
DOD	❖ Partnership Intermediary Agreement with S&L organization ➢ Maryland TEDCO
USDA	❖ USDA's "Know Your Farmer, Know Your Food Initiative" ➢ Areas within ARS signed a non-funded cooperative agreement with the Redevelopment Authority of the City of Philadelphia to develop a team effort to address issues in urban agriculture. ❖ Partnership Intermediary Agreement with S&L organizations ➢ Mississippi Technology Alliance ➢ Wisconsin Security Research Consortium of the Wisconsin Technology Council ➢ Pennsylvania Ben Franklin Technology Partners
Universities	❖ Service is generally a part of a university's mission, in addition to education and research. ❖ Technology transfer mechanisms are frequently designed to advance broader adoption and diffusion of available technologies. ➢ <u>Agricultural extension centers and programs</u> – Historically part of the mission of land grant institutions and T2 advanced through these centers and programs. ➢ <u>Manufacturing extension programs</u> – More recently, with support from NIST, a number of universities have developed these programs to deploy available technology to improve the competiveness of small and medium sized manufacturers in the US.
Industry	❖ <u>IBM's Municipal Shared Services Cloud</u> – Creates transparent and efficient interaction among governments, citizens, and business enterprises that is being piloted through the New York Conference of Mayors and Michigan Municipal League.

6. Other T2 Mechanisms

During our research of technology transfer best practices, there were a number of other mechanisms at in the various sectors that did not fit within the five mechanisms mentioned above, but we determined from our analysis to be effective methods for technology transfer. The following are examples of these other technology transfer mechanisms:

Consortium

To help facilitate Federal Technology Transfer from the laboratories, the Federal Laboratory Consortium for Technology Transfer was established. Through authorization in the 1986 Federal Technology Transfer Act, the FLC received a mandate for operation and required membership of most Federal laboratories using 0.008% of each agency's R&D budget to be set-aside from the laboratories as their membership fee.

Research Parks

Some of the national labs are establishing research parks either directly on the campus of the national lab or near the national lab's campus. These research parks that are being placed nearby offer an opportunity for the lab to collaborate with companies that are located in the research park and form partnerships. A few examples of national labs creating research parks are the following:

Table A-12: Research Park Examples

Industry Sector	Example(s) of Research Parks
National Labs	
DOE	❖ Oak Ridge National Laboratory ➢ Facilities for private companies near the national lab that offers the lab's scientists an opportunity to collaborate with these companies and form partnerships between the lab and the company ❖ Sandia National Lab ➢ Sandia Science and Technology Park – partnership between DOE, the City of Albuquerque, Technology Ventures Corporation, and Sandia to foster activities in technology transfer and commercialization between companies and the national lab ❖ Pacific Northwest National Laboratory ➢ Tri-Cities Science and Technology Research Park located close to the lab
Federal Agency	
NASA	❖ Research Park at NASA Ames

Research parks are a well-established approach to advancing closer industry-university partnerships and accelerating the pace of technology transfer among universities. In collaboration with the Association of University Research Parks, Battelle surveyed 174 university research parks in the U.S. and Canada in 2007. This survey found:

- Research parks have grown at a steady pace during the past three decades.
- Research parks are considered an effective tool to spur homegrown business retention and expansion.
- Research parks are placing greater emphasis on incubation and entrepreneurship.

- Research parks are focusing on targeted industry clusters.
- Research parks are being viewed as a commitment to economic development.

Technology Maturation Funding

A number of national labs have established technology maturation funding to help facilitate the transfer of technology. The purpose of technology maturation funding is to take internal funds to allow the inventor to perform further work on the technology in an effort to advance it or qualify beyond its current state, to help decrease the technical risk, and to make the technology a more attract candidate for licensing. Various national labs such as Los Alamos, Pacific Northwest and Oak Ridge have implemented this type of funding to help with technology maturation.

Among universities, it has become increasingly common for technology commercialization programs to operate funds that provide small amounts of very early-stage proof-of-concept activities. Such commercialization funds make awards ranging from $50,000 to $250,000. These funds are used to undertake due diligence to determine whether there is any commercial value. In some cases, the researcher may be provided small additional funds to further refine the “proof of concept” of the research. If value is discovered, then university IP procedures will come into play. The intent of this type of fund is to discover additional commercial opportunities unforeseen by the researcher who is untrained in examining market opportunities. The end result of a technology commercialization award will be a prototype, further research that helps determine market value, or other deliverables. Some commercialization programs also provide pre-seed or seed funding to start-up companies. The objective of university commercialization programs is to identify university developed technologies with commercial potential and develop that technology to the point at which a commercial partner can be found or a company created to market it. The goal is to advance ideas beyond proof-of-concept thus reducing risk for investors and customers.

These programs often include commercialization funds that seek to address the capital gap between basic science, which is most often funded by the Federal government, and the development of technology with commercial potential. One of the first was the William J. von Liebig Center at the University of California San Diego’s Jacobs School of Engineering. In six years, the von Liebig Center has achieved remarkable results: it has received more than 200 proposals and invested more than $3.8M in seed grants and advisory services to over 70 projects. These projects have resulted in more than 22 license agreements and helped launch 16 start-up companies. In turn, those start-ups have attracted more than $78 million in subsequent capital from the private sector and created over 130 new jobs.

APPENDIX B: T2 Best Practices in Other Industries Based Upon Surveys

A. Background

Battelle's Technology Partnership Practice and the University Transportation Center for Mobility within the Texas Transportation Institute at Texas A&M University conducted two separate web surveys to help gain a better perspective of technology transfer best practices in other industries.

The first survey was sent to 150 professionals in the technology transfer office at universities, Federal agencies, national labs and industry. This survey consisted of 21 questions. A total of 30 responses were received for a response rate of 20%.

A second survey was sent to directors and administrators at the 60 University Transportation Centers (UTCs) to identify their technology transfer best practices. This survey was tailored to the technology transfer activities of UTCs and contained a subset of the questions (i.e., a total of 10 questions) from the first survey For this survey to the UTCs, a total of 21 centers responded for a response rate of 35%. In the discussion of results that follow, the category of university includes responses from both surveys.

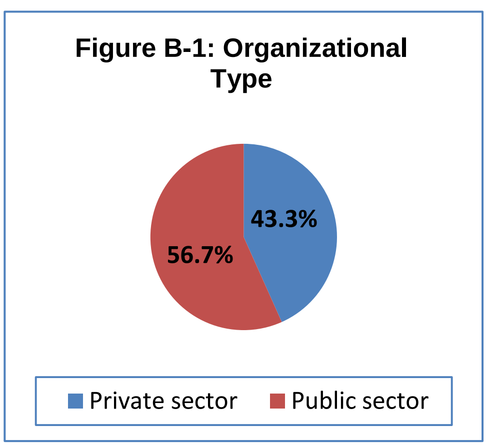
A synopsis of the responses to the surveys is presented in the following sections B and C:

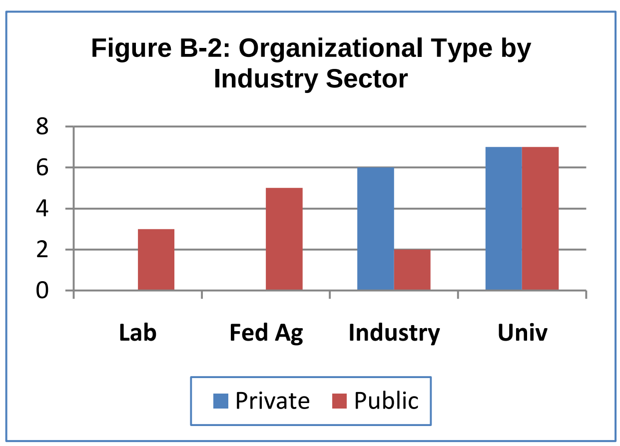
B. T2 and the Organization

This section summarizes the characteristics of the T2 organizations responding to the survey.

1. Organization Types

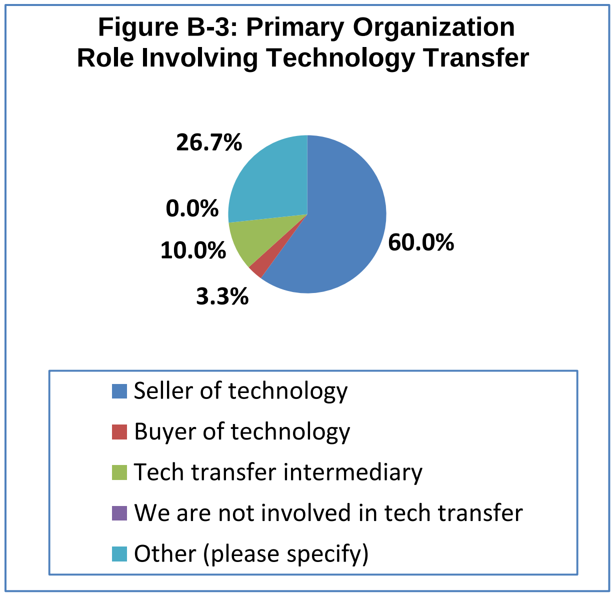
In Figure B-1, slightly more than half of the organizations (56.7%) that responded to the survey were from the public sector, while the remainder (43.3%) was private sector organizations. This distribution is slightly tilted to the public sector in Figure B-2 because there were responses from organizations across all of the sectors – eight responses were from Federal agencies and national labs; seven of the responses were from universities; and two from industry. Industry and the universities were the only organizations that represented the private sector.





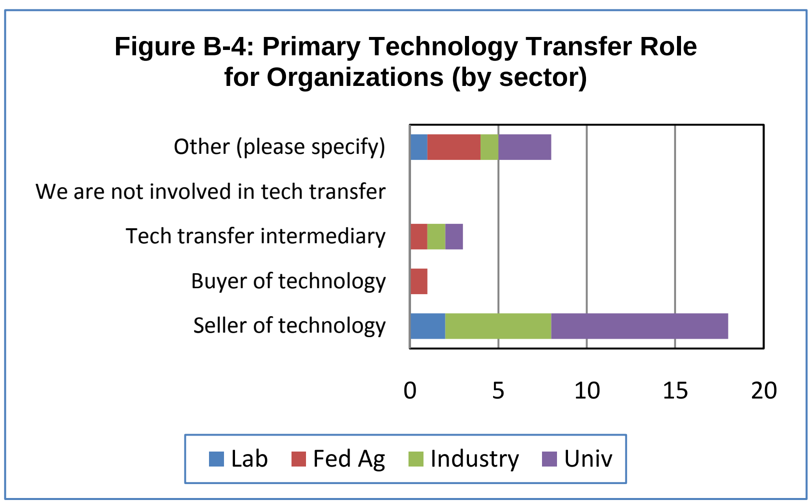
2. Primary T2 Roles for Organizations

In Figure B-3, for most of the other industries (i.e. national labs, industry and the university) that are involved with technology transfer, their primary role is to sell technology for their organization (60%). The other primary roles for organizations were technology transfer intermediaries that help facilitate the transfer technology to parties (10.0%) and buyers of technology (3.3%). The majority of the organizations that reported "other" considered their organizations to have the following responsibilities:



- Dual role as both a seller and a buyer of technology
- A university or Federally Funded Research and Development Center (FFRDC) with a non-profit mission
- Partner with the academia and industry.

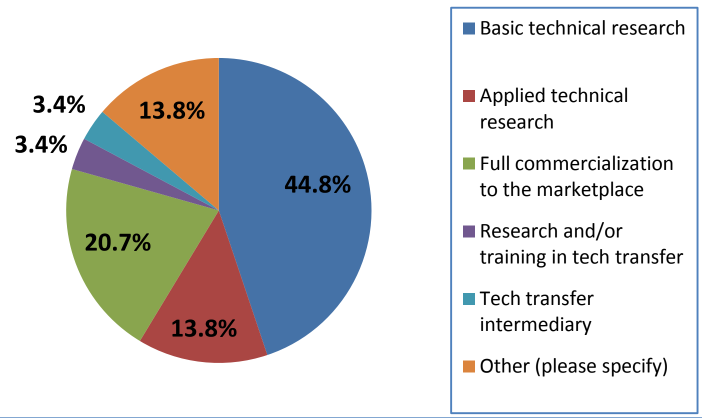
In Figure B-4, the primary role for organizations across the various sectors was either as a seller of technology or as technology transfer intermediary. Industry and universities are primarily involved with being a seller of technology; Federal agencies have a primary technology transfer role as a buyer of technology and technology transfer intermediary; and the primary role for national lab is as a seller of technology.



3. Research/Technology Transfer Activities

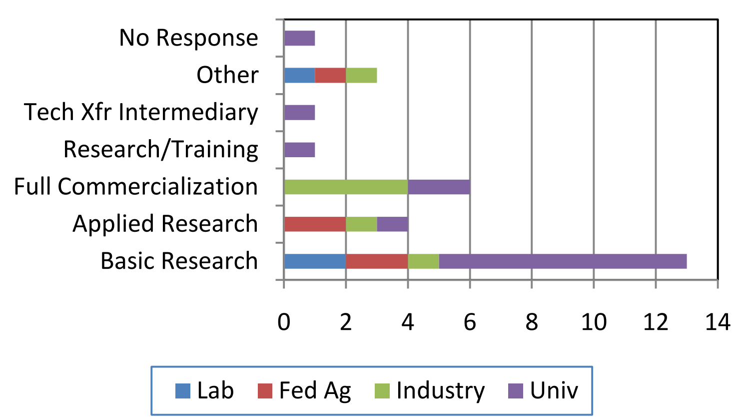
In Figure B-5, basic research continues to be the primary focus of most of the organizations' activities. This is one of the major reasons why technology transfer can be challenging because of the early stage of the technologies that these organizations are trying to transfer. A moderate number of organizations reported their primary focus to be on full commercialization and applied research activity.

Figure B-5: Primary Focus of Organization in Research/Technology Transfer Activities



When examining the research/technology activities for each sector (Figure B-6), universities are involved in all of the research/technology transfer activities with most primarily focused on basic research; the labs also have a primary focus on basic research; the Federal agencies activities are involved in the areas of basic and applied research; and industry is focused primarily on full commercialization with a few of these respondents involved with basic and applied research.

Figure B-6: Primary Focus of the Organization in Research/Tech Transfer Activities (by sector)



Most UTCs require a technology transfer component in all research projects. Some UTCs award funds for stand-alone T2 activities, including (by U.S. DOT definition) workforce development programs targeting K-12. The mission and theme of each UTC impacts its emphasis on T2. For example, one UTC's mission is technology transfer, and thus all projects must include a commercialization plan. Another UTC's mission is to conduct policy research, and thus T2 is limited to dissemination of research results. The UTC at San Jose State sets aside $3,000 for each research project specifically to support T2 activities, with half designated as a journal publication incentive and half awarded for post-research conference travel.

A final technical report is required by ITS JPO to be produced for all projects. The report must be accessible for download on the UTC's website, filed with several libraries and repositories, and listed in the Transportation Research Board's (TRB) Transportation Research Information Services (TRIS) database. Other standard methods of disseminating results are encouraged or required by most UTCs, including publishing in peer-reviewed journals and presenting results at professional conferences and stakeholder meetings. Several UTCs encourage or require PIs to provide media-friendly project summaries at the end of the project. The following examples highlight a few of these activities.

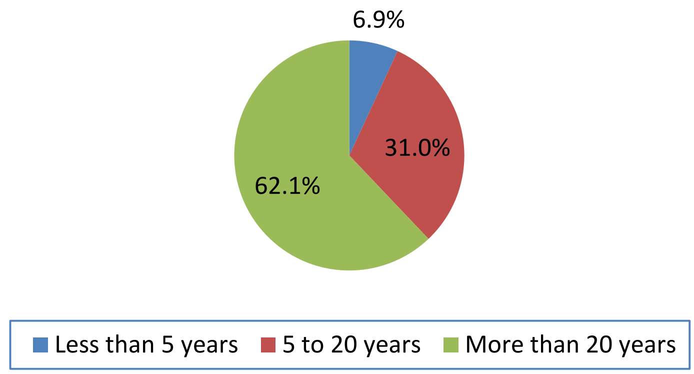
- The University of Alaska requires all PIs to prepare a 15-20 minute PowerPoint presentation with voice over as a part of the final report. This is a new program, but it appears to be well-received by the research managers at the Alaska Department of Transportation & Public Facilities.
- The University of South Florida utilizes pre-recorded streaming presentations for on-demand playback. These 10-25 minute conference-style presentations are intended to help convey what the research was about and the findings. In the fall of 2010, the UTC launched a bi-weekly Webcast series that will feature research projects.
- At the University of Michigan, each project team is required to film a five-minute video as a part of the UTC's "Web Briefings" program. The videos describe the methods, results, and implications of the project and allow any interested person to access the video and understand the research without having to read the entire technical report.
- At Cal State-San Bernardino researchers convert their final research reports into a 2-3 minute script, which is used to podcast the results on the Leonard Transportation Center's iTunes U website.

Some UTCs require advisory review from the beginning of the project by stakeholders, potential clients or other practitioners from Federal, state, and local agencies or private industry to ensure research is client-driven and to increase the likelihood of implementable results, including commercialization.

4. Organizational Involvement in T2 Activities

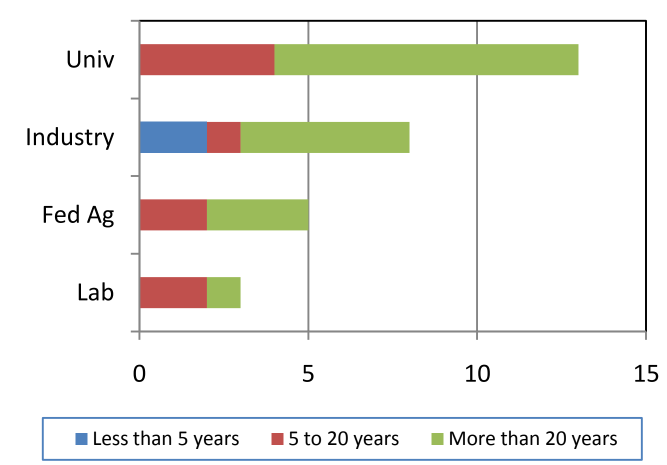
The organizations that responded to the survey in Figure B-7 have a great deal of experience in technology transfer – sixty-two percent reported involvement with technology transfer for more than 20 years; thirty-one percent have been involved with technology transfer for 5 to 20 years; and only 6.9% have had technology transfer activities in their organization for less than 5 years.

Figure B-7: Length of Time Organizations have been Involved in Technology Transfer Activities



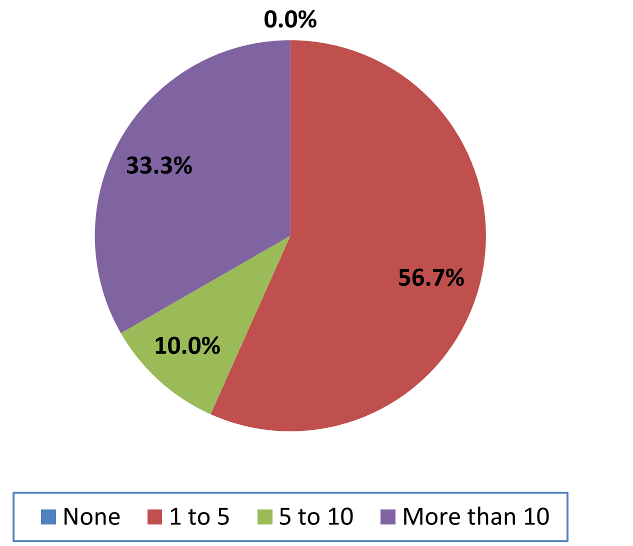
In Figure B-8, the universities, national labs and Federal agencies all have had the most experience in technology transfer activities. These activities have been driven by the Federal policy and legislation that was put in place to make Federally funded technologies available to the marketplace. Industry is the only sector that has organizations with less than five years of experience in technology transfer activities. This has occurred because only recently has industry started to look at new opportunities to provide their technologies and applications to the Federal agencies and national labs as part of their Technology Transition efforts.

Figure B-8: Duration of Organizational Technology Transfer Activities (by Sector)



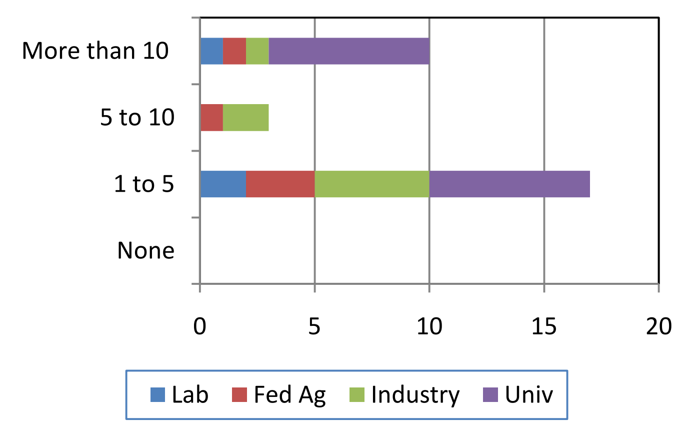
5. Size of Technology Transfer Staff

Figure B-9: Technology Transfer Staff Size



In Figure B-9, the size of the technology transfer staff for the majority (56%) of the organizations that responded to the survey is small (1 to 5 employees). Thirty-three percent of the other organizations that responded to the survey have large staffs, and this was typically the organizations that have been involved with technology transfer for more than 20 years. The remainder of the organizations (10%) that responded indicated that they had mid-size staffing (5 to 10 staff members) involved with their technology transfer activities.

Figure B-10: Size of Technology Transfer Staff (by Sector)



When looking at the responses for the survey by sector in Figure B-10, the national labs, Federal agencies, university and industry all have technology transfer staff sizes ranging from small to large. This is likely the result of the variability in the amount of research funding available for these institutions, which has an impact on how many staff is allocated to technology transfer activities. Additionally, the variability in the industry sector may be due cost pressures that public companies face to remain profitable. Since technology transfer is typically a cost center for most organizations, the staffing will be sized accordingly.

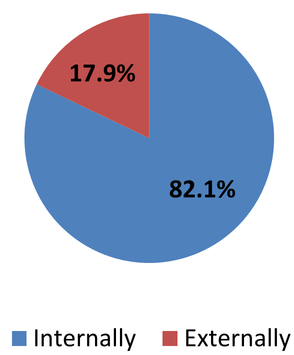
C. T2 Approach

This section presents the findings on the T2 approaches from the surveys.

6. Approach to Funding of Technology Transfer Activities

In Figure B-11, the approach that organizations utilize to fund their technology transfer activities is primarily internal funding (82.1%). This is because most organizations would like to encourage their staff that is involved in these types of activities to be entrepreneurial and move the technology transfer operation from being a cost center to a profit center.

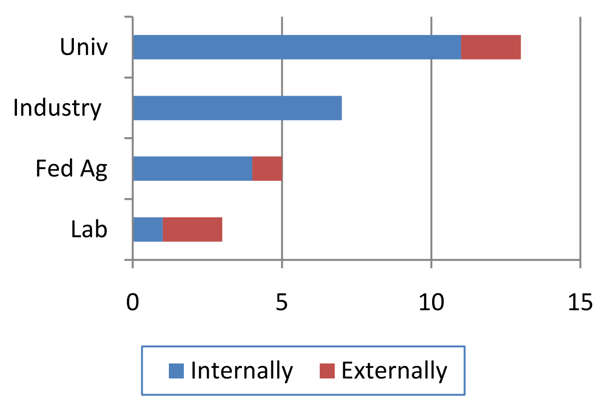
Figure B-11: Technology Transfer Funding Approach Used by Organizations



The only sector in Figure B-12 that does not use any external sources to fund their technology transfer activities is industry, which only uses internal funds. The other industry areas, Federal agencies, national laboratories and universities use a variety of external methods to support their technology transfer efforts including the following:

- One national lab is using privately funded technology transfer for patenting and licensing activities
- Another national lab and a university indicated that they are using royalties from licenses
- One university indicated that it is using Federal, state and industrial sponsored research

Figure B-12: Methods Used by Organizations to Fund Technology Transfer

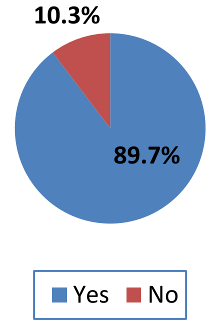


The majority of UTCs (all but the seven that designated in Title III and funded through the Federal Transit Administration) have a Federal 1:1 match requirement, which is fulfilled from a variety of sources, including state DOTs, local transportation agencies, private industry, and funds from the home universities of UTCs. These sources are often tapped for T2 funds. Other T2 sources include other Federal programs, the Local Technology Assistance Program (LTAP), revenue from commercialized products, and user fees. A few UTCs rely only on UTC funds for T2.

7. Formal Technology Transfer Policy in Organizations

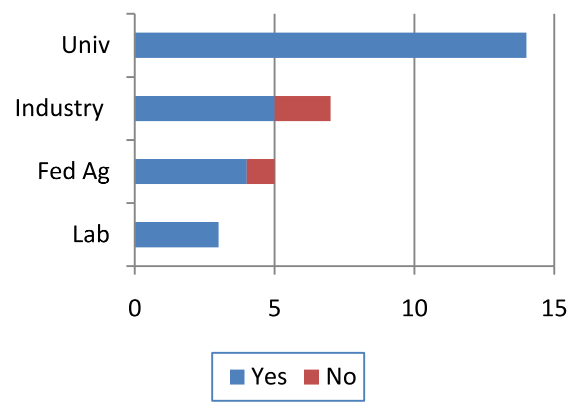
In Figure B-13, eighty-nine percent of the organizations that responded to the survey had a formal technology transfer policy with guidelines and a little over ten percent (10.3%) did not have a formal technology transfer policy. The reason why the majority of the organizations have a formal technology transfer policy is because they receive Federal funding for their research and in exchange for this funding they must follow the Federal guidelines to attempt to transfer any intellectual property developed into the marketplace.

Figure B-13: Do you have a Formal Technology Transfer Policy with Guidelines?



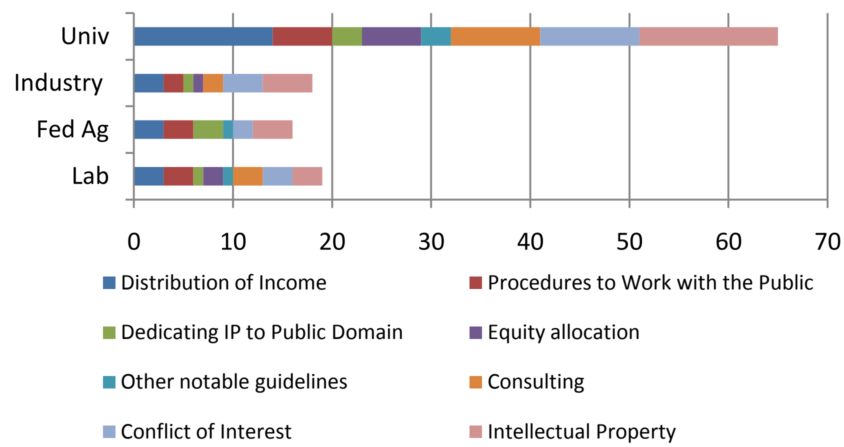
The organizations that did not have a formal technology transfer policy in Figure B-14 were in industry and a Federal agency. It is not surprising to see industry not having a formal technology transfer policy since most of these organizations have traditionally focused on commercializing their own technology, but one Federal Agency did not have a formal technology policy because it does not develop its own intellectual property. This organization is focused on funding research that may be transferred to other organizations. Each of the organizations for each sector in Figure B-14 reported that they had a formal technology transfer policy with all of the universities indicating that they have a formal technology transfer policy.

Figure B-14: Organizations with Formal Technology Transfer Policy with Guidelines (by sector)



8. Technology Transfer Policy Guidelines Addressed

Figure B-15: Technology Transfer Policy Guidelines Addressed (by Sector)



All of the organizations that responded in Figure B-15 indicated that intellectual property was addressed by their technology transfer policy. Some of the areas that were addressed by the technology transfer policy were the following: distribution of income; conflict of interest; procedures for working with the public; consulting; equity allocation in start-up companies; and dedicating IP to the public domain. "Other" technology transfer policies that were addressed by the organizations technology transfer policy were the following: partnerships, processing and handling proprietary data, processing software data, and returning IP to inventors.

Universities were the one sector that has taken the broadest steps to generating technology transfer guidelines and this reflects that high level of technology transfer activity in this sector. The other sectors have a smaller amount of guidelines when compared to the universities.

9. Most Effective Types of Technology Transfer

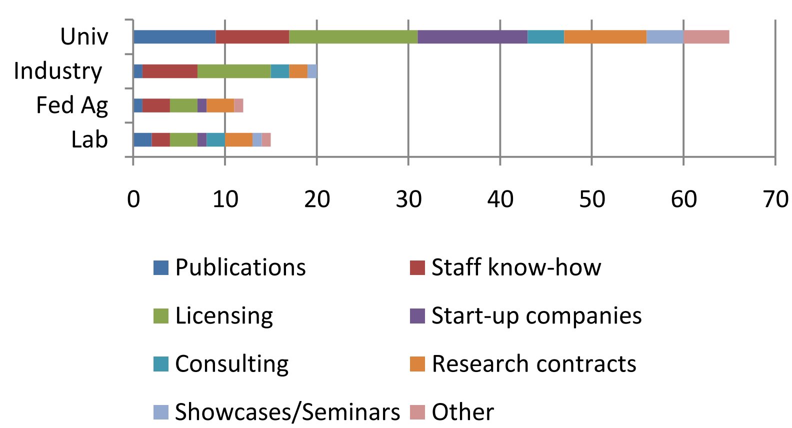
In Figure B-16, licensing is the most effective form of technology transfer performed by other industries with 93.1% of the organizations that responded to the survey considering this as an effective activity. Surprisingly, the second most effective technology transfer method is staff know-how at 65.5%, which is a method that cannot be easily measured by the organizations and is typically not included as part of their annual metrics. The third most reported method of technology transfer is research contracts, which was reported by 58.6%. This was expected to be higher given that research is a key part of the mission for most of the organizations that responded the survey. Start-up companies and publications were considered almost equally effective in technology transfer by the respondents comprising 48.3% and 44.8% of the responses respectively. These methods were followed by consulting and "other" methods of technology transfer such as CRADAs, faculty contacts, students and special events at 27.6% and 24.1% respectively. The lowest identified method of technology transfer was showcases/seminars at 17.2%.

Figure B-16: Most Effective Types of Technology Transfer

Technology Transfer Method	Percentage of Total	No. of Responses
Licensing	93.1%	27
Staff know-how	65.5%	19
Research contracts	58.6%	17
Start-up companies	48.3%	14
Publications	44.8%	13
Consulting	27.6%	8
Other, please describe	24.1%	7
Showcases/Seminars	17.2%	5

When examining the methods of technology transfer by industry in Figure B-17, the university and industry sectors look towards licensing as the most effective means of technology transfer, while the national labs and Federal agency consider licensing just as effective as research contracts. Staff know-how is one of the top three methods of technology transfer across all of the other sectors. Universities were the only sector that considered start-ups as an effective type of technology transfer.

Figure B-17: Most Effective Types of Technology Transfer (by Sector)



10. Programs or Components to Facilitate Technology Transfer

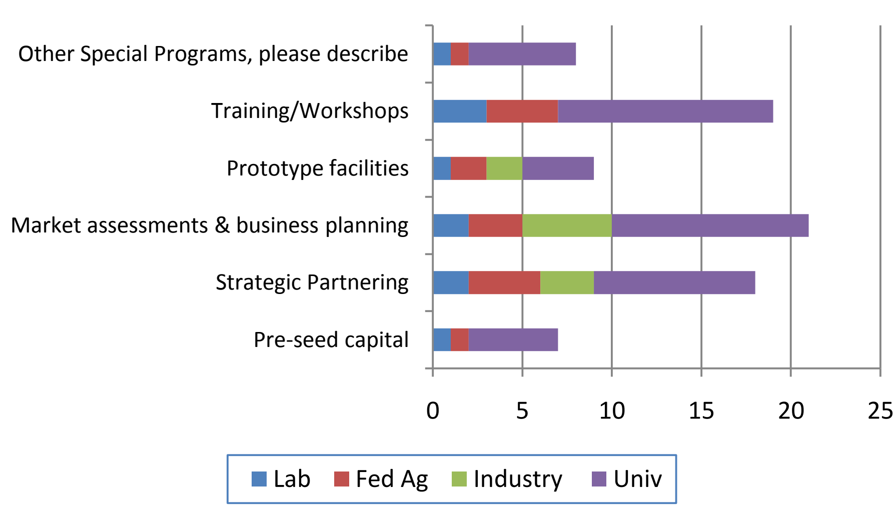
Figure B-18: Programs or Components to Facilitate Technology Transfer

Programs or Components to Facilitate Technology Transfer	Percentage of Total	No. of Responses
Market assessments & business planning	77.8%	21
Training/Workshops	70.4%	19
Strategic Partnering	66.7%	18
Prototype facilities	33.3%	9
Other Special Programs, please describe	29.6%	8
Pre-seed capital	25.9%	7

Other organizations reported using a variety of programs and tools in Figure B-18 to help them facilitate technology transfer in their organizations. These first three types of programs or components were clearly the leaders based upon the response rate. Market assessments & business planning was the leading program or component that they used to facilitate technology transfer at 77.8%. The second type of program or component that they used to help facilitate technology transfer is training/workshops at 70.4%. Strategic partnering was reported as the third leading program or component used to help facilitate technology transfer at 66.7%. The fourth program or component used to facilitate technology transfer was prototype facilities at 33.3%. The last two program or components used to facilitate technology transfer, other special programs (such as marketing to the community, entrepreneurs in residence, interns, proof of concept programs, and including technology transfer in proposals) and pre-seed capital, were reported at 29.6% and 25.6% respectively.

When looking at the program and components used to facilitate technology transfer by organization in Figure B-19, industry and many universities considered market assessments & business planning as one of their top programs or components to help facilitate technology transfer. Training/ workshops were considered one of the top three programs or components for universities, labs and Federal agencies. This is not surprising given that these organizations are expected to share their knowledge with the public sector. Strategic partnering was one of the top three programs or components among of the organizations that responded to the survey. Universities were the one sector that primarily implemented pre-seed capital and other programs as a program or component to facilitate technology transfer.

Figure B-19: Programs or Components to Facilitate Technology Transfer (by Sector)

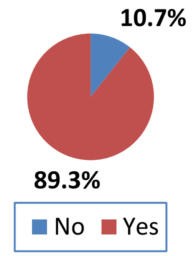


All UTCs are required to engage in technology transfer designed to disseminate information on UTC research and other activities, including maintaining a website and publishing a newsletter and annual corporate-style report. Most UTCs engage in additional non-project related technology transfer activities. Most common is the hosting of a seminar series and webinars, student research conferences, professional conferences, and workforce development activities targeting either K-12 or working professionals.

11. Supervision of Technology Transfer in Organizations

In Figure B-20, eighty-nine percent of the organizations reported having an individual solely responsible for directing their technology transfer. This is indication that most organizations consider technology transfer an important function in their organization where they need an individual to help lead their efforts.

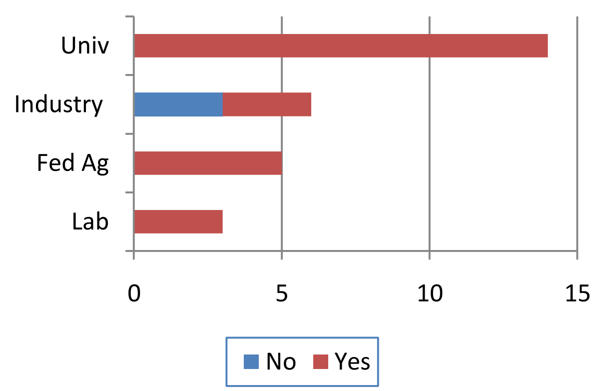
Figure B-20: Organizations with Individual(s) Solely Responsible for Directing Technology Transfer



When examining the responses on which sectors have an individual solely responsible for leading the technology transfer efforts in Figure B-21, one can see that all of the sectors have an individual with leading technology transfer activities except industry. Some of the industries may not have an individual responsible for solely directing technology transfer activities because they may have a primary focus on developing their own products and do not consider it profitable to have a focus on transferring early stage technologies into their organization for development.

UTCs manage their T2 activities with a wide variety of staffing arrangements, ranging from the UTC Director handling all aspects of T2, to an Associate Director for T2, to administrative staff ranging from one to several persons and including student help. Some UTCs employ T2 staff only for the communications aspects of T2 (webmaster, publications, social media, marketing, and public relations) while others include developing ties with industry and public agencies and other clients in their duties.

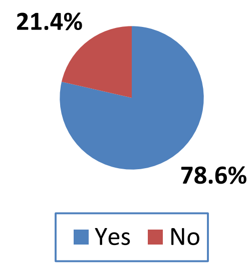
Figure B-21: Individual(s) Responsible for Leading Technology Transfer in the Organization (by Sector)



12. External Resource Support for Technology Transfer

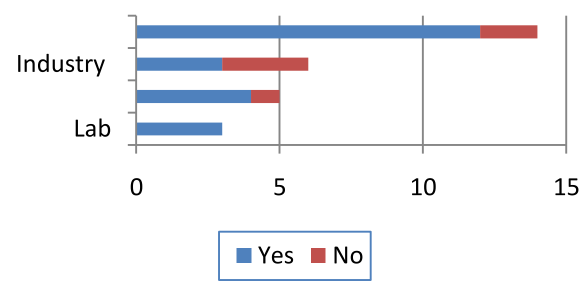
Approximately seventy-nine percent of the organizations that responded to the survey in Figure B-22 indicated that they use external support resources for technology transfer organizations. This shows that most organizations need a variety of external resources to perform in-house technology transfer roles that they cannot or elect not to staff.

Figure B-22: External Resource Support for Technology Transfer in Organizations



In Figure B-23, it was reported by all sectors that they utilize external resources to support their external activities. The national labs were the only sector that did not report in the survey the use of external resource support.

Figure B-23: External Resource Support for Technology Transfer in Organizations (by Sector)



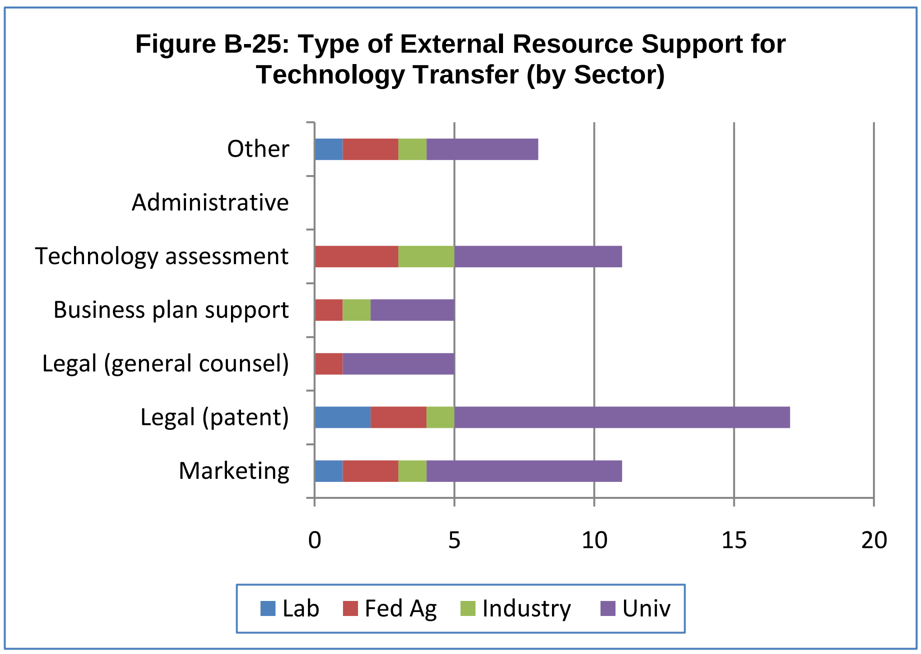
13. External Tech Transfer Support

Figure B-24: External Support Resources for Technology Transfer

Type of External Resource Support for Technology Transfer	Percentage of Total	No. of Responses
Legal (patent)	77.3%	17
Technology assessment	50.0%	11
Marketing	45.5%	10
Other	36.4%	8
Legal (general counsel)	22.7%	5
Business plan support	22.7%	5
Administrative	0.0%	0

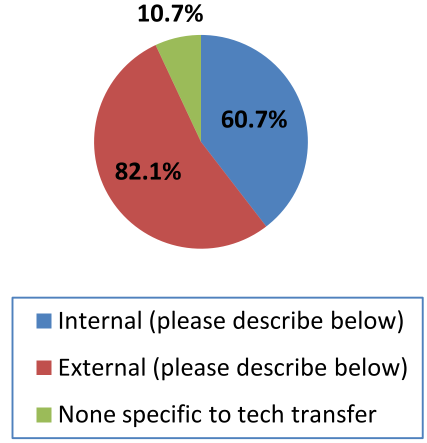
The leading external resource that is being used by the institutions that reported to the survey in Figure B-24 is legal patent support (77.3%). Organizations also reported that they get external resource support services for the following areas: 1) Technology assessments; 2) Marketing; 3) Legal (General Counsel); and 4) Business Plan support. Some of the other areas where the institutions receive external support are partnership intermediaries, patent search software firms, external contract attorneys, and joint support from other Federal agencies.

Across all of the sectors in Figure B-25, legal (patent) support was the primary external support resource that is being used by technology transfer organizations. The other area that was frequently reported by most of the sectors as the type of external resources used to support technology transfer was technology assessments and marketing. Universities were the sector that most frequently reported the use of other external resources.



14. Types of Training for Professionals in Tech Transfer

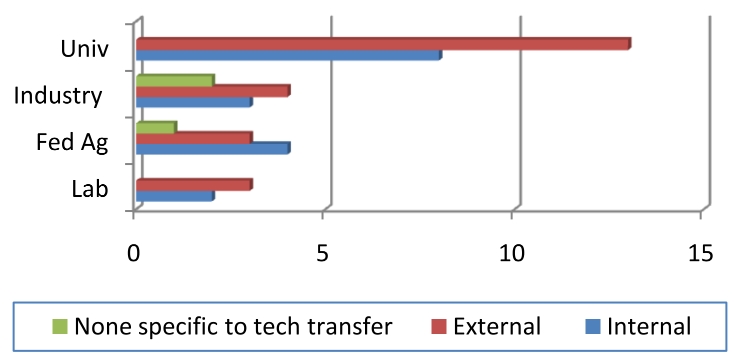
Figure B-26: Types of Training or Professional Education for Professionals in Technology Transfer



Overall, only about 11% of the organizations reported in Figure B-26 that they do not pursue any specific training for professionals in technology transfer. The majority of the organizations had their professional pursue some type of training in technology. Eighty-two percent of the organizations reported that they pursue external training or professional education to help enhance the skills of professionals in technology transfer, while approximately 61% of the organizations reported using internal training or professional education in technology transfer.

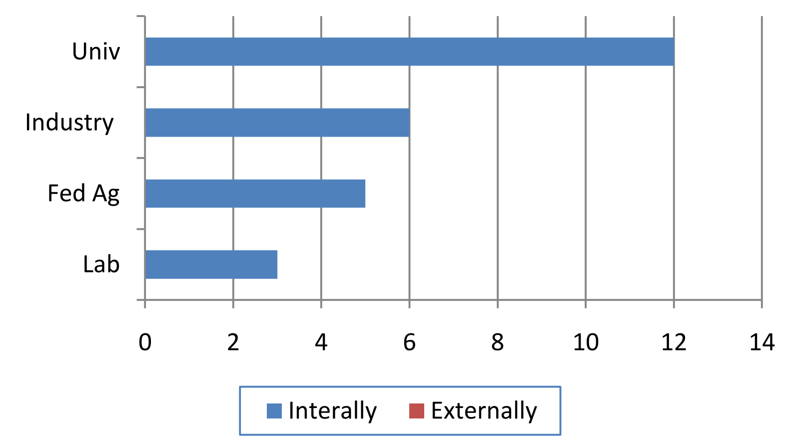
In Figure B-27, it is shown that all of the sectors reported that they pursue some type of external or internal training for professionals in their organizations. The Federal agencies were the organizations that provided the most details about their internal training that included the following: 1) DOD integrated product team workshop for technology transfer; 2) a four hour course in technology transfer for new employees; and 3) DHS Headquarters providing technology transfer training. In addition, many of the organizations stated that they pursue external training through professional societies in technology transfer such as Association of University Technology Managers, Licensing Executives Society and the Federal Laboratory Consortium.

Figure B-27: Types of Professional Skills and Training for Professionals in Technology Transfer (by Sector)



15. Patent Decision-Making in Organizations

Figure B-28: Patent Decision Making Process in Organizations (by Sector)



In Figure B-28, all of the organizations (i.e. 100%) that responded to the survey indicated that they make the decision on whether or not to patent a disclosed invention internally. The leading methods that the institutions revealed that they use to make the decision on whether to patent are technology transfer staff, patent committees and asset management teams. Patent committees were the method that was sited most frequently when examining the responses by sector.

16. Methods Used by Organizations for Patent Costs

The majority of the organizations reported in Figure B-29 that they primarily utilize internal funds (96.4%) to fund their patent costs. A few organizations use external funds for their patent costs (17.9%), or a combination of internal and external funds to support these efforts.

In Figure B-30, it is shown that all of the organizations across the different sector use internal funds to pay for their patent costs. The two types of organizations that reported using external patent funds for their patent costs were universities and national labs. The external methods that they used to pay for their patent costs were license fees/royalties – reported by both the universities and national labs, and the use of privately funded technology transfer was reported by the national labs.

Figure B-29: Methods Used by Organizations for Patent Costs

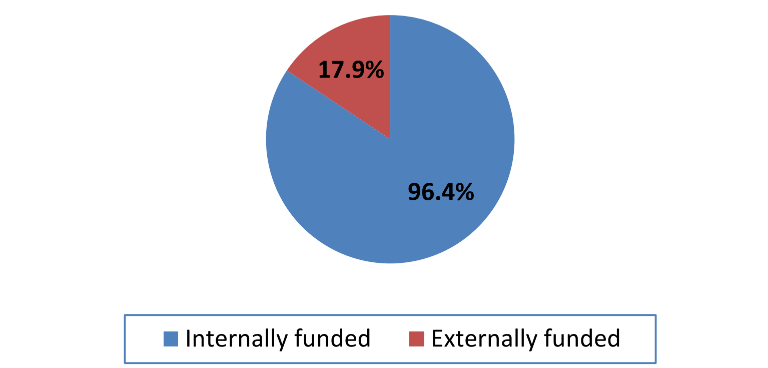
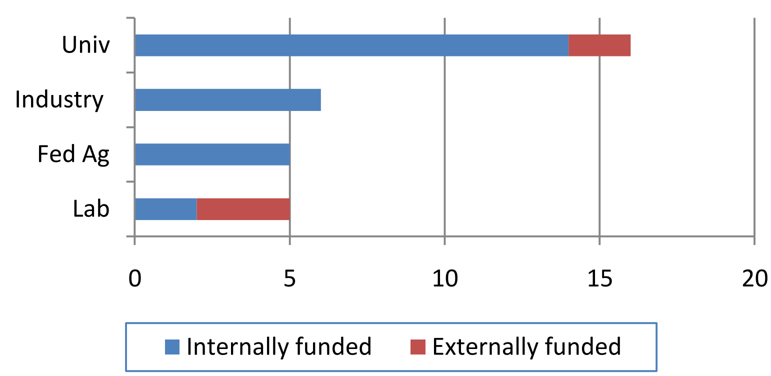


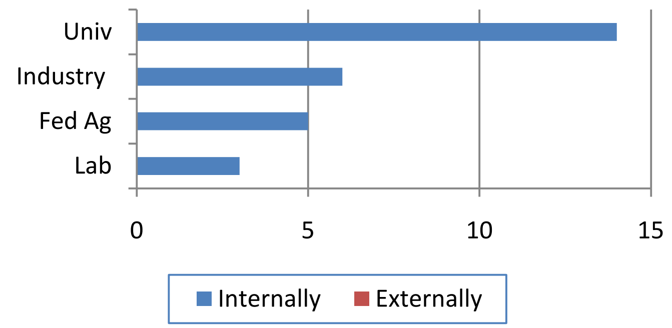
Figure B-30: Methods Used to Fund Patent Costs (by Sector)



17. Method Use to Identify IP Licensing

All of the institutions that responded to the survey in Figure B-31 indicated that they use internal resources to identify and assess intellectual property for licensing. The leading method that was described by the institutions to identify and assess IP was technology transfer staff. The other methods reported were patent committees, triages, and publicly available information.

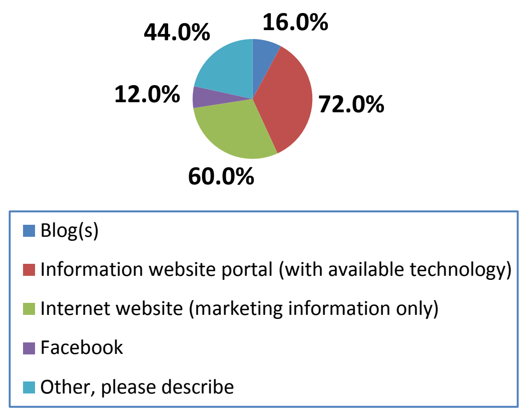
Figure B-31: Method Utilized to Identify and Assess IP for Licensing (by Sector)



18. Electronic Marketing Channels Used for Tech Transfer

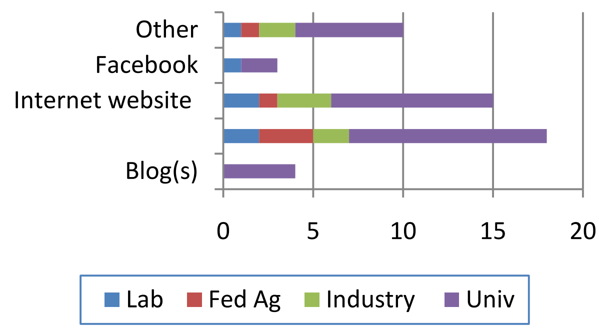
In Figure B-32, organizations reported using a variety of electronic marketing channels for technology transfer. From the survey results, organizations are primarily using the internet (i.e. a website portal at a 72% response rate, or a marketing website at a 60% response rate) as electronic market channels to help market their available technologies. It should also be noted that organizations are starting to use the social media tools such as blog(s) and Facebook to help facilitate technology transfer, which had a 16% and 12% total response rate respectively. Organizations are also using a number of other electronic marketing channels such as LinkedIn, Twitter, direct marketing and links to available technologies on the inventor's web page.

Figure B-32: Electronic Marketing Channels Used by Organizations for Technology Transfer



When examining the survey results by sector in Figure B-33, it is shown that all of the sectors (i.e. universities, industry, national labs, and Federal agencies) are using the Internet to electronically market their available technology. Additionally, all of the sectors are trying out "other" electronic channels to market their intellectual property.

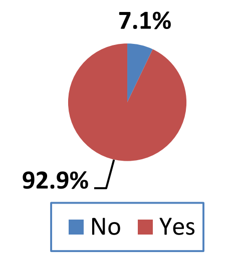
Figure B-33: Electronic Marketing Channels Used by Organizations for Technology Transfer (by Sector)



All of the UTCs are required to maintain a website that documents current and historical center activities. Many UTCs are also experimenting, some quite successfully, with various social media technologies, most often including Facebook, Twitter, LinkedIn, webcasting and iTunes U/podcasting. A few are using RSS feeds, YouTube, and wikis. One UTC noted they had tried a blog with little success. While the UTCs using these newer methods of social media recognize the benefit of "pushing" information out to constituents, common concerns include information overload for users and the need to have attractive, timely, and frequent briefs across a variety of media services, all of which are resource and labor intensive.

19. Measurement of Technology Transfer Performance

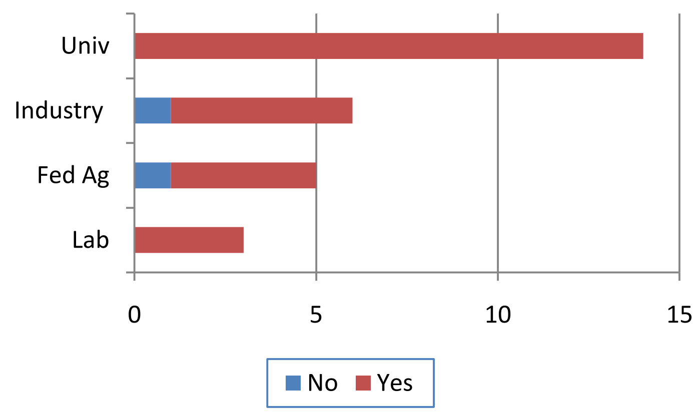
Figure B-34: Organizational Performance Measurements in Place for Technology Transfer Efforts



Based upon the responses provided in Figure B-34, approximately 93% of the organizations have performance measurements in place to help evaluate their technology transfer performance. The specific measurements reported by the organizations include the following:

- Invention Disclosures
- Licensing income
- Number of licensing agreements
- Client satisfaction
- Legal expense reimbursement
- Job creation
- Societal benefit
- Commercialization success

Figure B-35: Organizational Performance Measurements in Place for Technology Transfer Efforts (by Sector)



In Figure B-35, organizational performance metrics are in place for the technology transfer efforts for all of the sectors surveyed. The only two sectors that reported not having performance measurements in place for their technology transfer activities was one Federal agency and one representative from industry. The Federal agency indicated that it does not have performance measurements in place because it is a funder of technology research.

20. Lessons Learned from the Implementation of Technology Transfer

The following provides details of the lessons learned from the various industry sectors that responded to the survey:

Table B-1: Lessons Learned from Tech Transfer in Other Industry Sectors

	Industry Sector			
	Federal Agencies	**National Labs**	**University**	**Industry**
Tech Transfer Topics				
T2 Process (in General)	• It is difficult and time consuming • Rewards for inventions and technology development will not encourage TT in and of themselves. It takes a culture of TT thinking. • Tech transfer is a contact sport – need to reach out	• Allow room for failure as you cannot pick winners every time and individual effort reaps rewards elsewhere. • Getting from a basic invention to product is usually impossible; takes lots of money and time.	• Takes time, perseverance, faith, trust and patience • It is a contact activity – need to mix online with face to face • Promotion of entrepreneurial culture • Very few BIG hits – about 1 per 10 years • Align the ecosystem • Be patient, be persistent, be a cheerleader for the effort but manage expectations.	
Policy			• Compliance to Federal funding agencies • Provide services and reward to faculty inventors	
Management and Operations		• You need a varied team of professionals: MBA, Legal, Scientific, Artistic (publications)	• Teamwork (licensing plus legal plus marketing plus business development) • Involve everyone • Get scientifically trained, industry experienced people • Staff with people experienced at successfully pulling technology from universities (vs. pushing out) • Treat the inventor as a valued customer • Focus on sales ability • Develop a division of labor that makes sense	

Table B-1: Lessons Learned from Tech Transfer in Other Industry Sectors (Continued)

	Industry Sector			
	Federal Agencies	**National Labs**	**University**	**Industry**
Intellectual Property	• Tech transfer is not about IP all the time		• Decisions are hard to make on patenting since tech is early stage • Don't be afraid to turn the technology back to the inventor • Not all patent attorneys are equal; use several external law firms • Don't accept more than 25% of the invention disclosures received for patenting. First do only provisional apps and use the time wisely. Cut expenses swiftly. Start-ups are troublesome but often times necessary.	• It has demonstrated the value of broadly based patent claims with emphasis on electronics. • Work with key inventors for each product line is most productive in terms of indentifying potential items for tech transfer. Earlier efforts based on central staffs were far less productive.
Licensing	• Close link with end user from the early stages of research • Constancy of passionate researcher/entrepreneur through several years	• New materials take about 10 years to get to market from patent receipt.	• Service components to faculty benefits the disclosure – licensing process • Proactively targeting internal research expertise and cross-disciplinary opportunities that meet market needs	• International Technology license projects always take a long time to develop and implement – patience is virtue • Be sensitive to the culture of licensee – national and organizational • Take time to write a comprehensive contract – no short cuts or verbal promises
Cooperative R&D/Partnerships	• You get more interest when you team with other agencies on technology specific areas			
Technical Assistance				
Information Exchanges	• It requires constant education of our scientists and engineers, as well as senior leadership on the benefits to themselves and the organization of TT.	• Getting publications out are often time more important than disclosing inventions.	• Education of inventors • Educating your researchers on IP is very important	

Table B-1: Lessons Learned from Tech Transfer in Other Industry Sectors (Continued)

	Industry Sector			
	Federal Agencies	**National Labs**	**University**	**Industry**
Public Sector		• Constantly inform and teach scientist and engineers, and upper mgmt, on the benefits to the US via innovation.	• Benefit the general public	
T2 Metrics			• Inappropriate to focus solely on ROI • Should not view this a $$ making operation since most inventions do not make $$ • Income from inventions from early stage basic research unpredictable • It's a numbers game – focus on generating invention disclosures by serving the faculty well and then focus on doing as many deals as possible, not on how much you make off of every deal. • Unless lucky, expect ~10 to 15 years for break even or substantial gain. Don't expect returns > 10% of research dollars expended.	• Business Units and or Product Lines need to see the direct financial benefit from tech transfer to adequately resource and support tech transfer.
Trends			• Startups becoming a more and more important component of our activities	

APPENDIX C: Case Studies

The following sections provide the case studies with the details about the technology transfer best practices for each of the organizations interviewed as part of this project.

1. University Transportation Center: Texas Transportation Institute (TTI)

Background

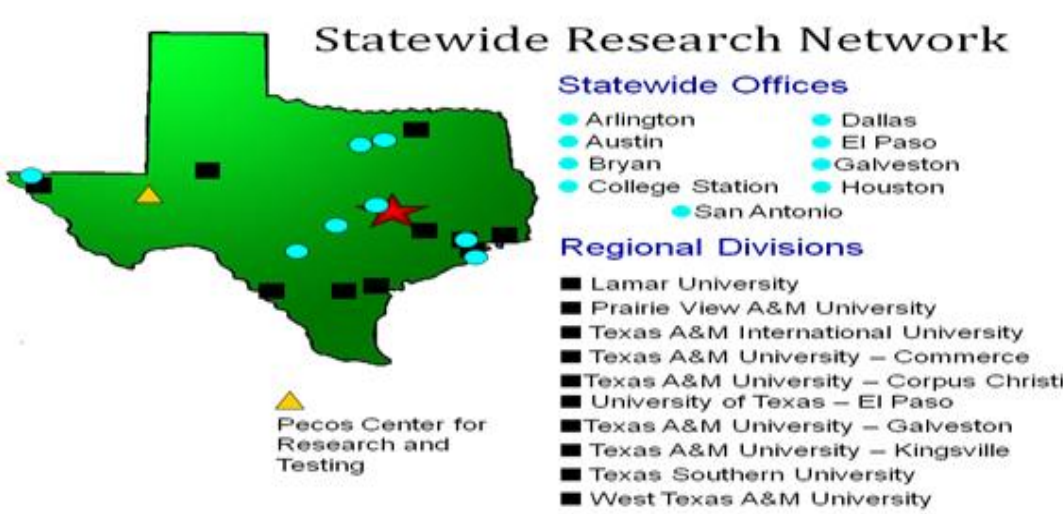
TTI has conducted research for a wide range of sponsors since its establishment in 1950. The Institute has completed research for Federal, state, and local agencies, foreign governments, private non-profit foundations, private sector groups, trade associations, and technical societies.

With headquarters on the Texas A&M University campus in College Station, TTI maintains laboratories and research facilities in Bryan and College Station and a testing center in Pecos. TTI has a number of facilities in the Bryan/College Station area: the Institute's State Headquarters and Research Building and the Gibb Gilchrist Building are located in the Texas A&M Research Park on the west campus and the CE/TTI Building is located on the main campus.

Researchers at TTI's seven urban offices work with local and regional transportation agencies to develop local solutions, foster cooperation, and implement research results. The Institute forms partnerships with other universities through regional divisions, which allow greater focus on region-specific transportation solutions. Figure C-1 illustrates the locations of these offices and regional divisions. The Institute's newest offices are located in Doha, Qatar, on the campus of Texas A&M University at Qatar and at the Texas A&M University Center in Mexico City, Mexico.

TTI's expansive field-testing facilities are essential in providing real-world findings to state, national, and international sponsors. Located 10 miles from the main campus of Texas A&M University, TTI's Riverside Campus is home to many testing facilities. The campus provides the realistic conditions needed for crash testing; pavement friction and smoothness testing; erosion and sediment control product testing; environmental and emissions testing; and traffic engineering studies. These comprehensive facilities contribute to TTI's ability to provide full-service transportation research solutions.

Figure C-1: Location of TTI Offices and Facilities



T2 Policy

As a federally supported program, TTI's technology transfer policy is driven by the sponsoring agency, United States Department of Transportation (U.S. DOT). Technology transfer is included as part of the mission of all of the University Transportation Centers such as TTI, which emphasizes the availability of research results that can leveraged by potential users in the public and private sector.

The research conducted by TTI focuses primarily on solving high-priority problems for its sponsors. Accordingly, the philosophy of the Institute is that research findings should be applied in the real world as quickly as possible. Thus, TTI's research program is noted for producing practical solutions to critical problems and implementing, evaluating, and refining the results from research projects.

T2 Mechanisms

Technology transfer has been a major ongoing focus of the Institute. TTI uses a wide range of technology transfer techniques. Examples of these techniques include workshops, seminars, training courses, on-line training, websites, DVDs and CDs, and publications. The Institute also holds patents on numerous products and licenses these products to private firms. Examples of technology transfer programs and activities are highlighted in this section.

University Transportation Centers

TTI is home to two University Transportation Centers (UTCs) – the Southwest University Transportation Center (SWUTC) and the University Transportation Center for Mobility (UTCM). The SWUTC is a partnership with the University of Texas at Austin and Texas Southern University in Houston. The two UTCs are administered by the Research and Innovative Technology Administration (RITA) at the U.S. DOT. Technology transfer is a significant component of both the SWUTC and the UTCM. In addition, TTI was recently selected by the U.S. DOT to operate the Transportation Economics Center (TEC). Technology transfer is also an important element of the TEC.

The SWUTC and UTCM use a wide range of technology transfer methods. More traditional approaches include workshops and conferences, reports, newsletters, videos, and CDs. More recent approaches focus on the Internet, social media, and other technologies. Examples of SWUTC and UTCM technology transfer activities are highlighted below.

- **Facilitating the Creation of Transit System Technology User Groups.** This UTCM project included research and technology transfer components. The research included completing an inventory of scheduling and dispatching computer software in use by rural transit systems in Texas. Plans for technology upgrades and expansion, issues faced with current software, and other concerns were also documented. The results were presented at a panel discussion at the Texas Department of Transportation (TxDOT) Public Transportation Division's Semi-Annual Transit Provider's meeting in July 2010. The panel also included individuals from rural transit agencies discussing their experiences with different software. Follow-up activities include maintaining a technology user group with ongoing assistance from TTI researchers.
- **Transportation Tourism Conference.** A SWUTC project in the early 2000s planned and conducted a conference on transportation and tourism. Participants discussed current research, projects, and experience linking transportation and tourism in Texas. The UTCM has funded a follow-up conference in 2011.

TxDOT Implementation Program

The TxDOT Implementation Program was initiated in 1999. It is administered by the Department's Research and Technology Implementation (RTI) office, which also manages the overall research program. The Implementation Program was undertaken in response to the realization that human resource and/or budget limitation within TxDOT districts or divisions may delay or prevent the implementation of research results which provide time-savings and budget-saving innovations.

The Implementation Program allows TxDOT to fund university researchers to assist in implementing research products. TxDOT considers the results from a research project to be a product. Thus, a product may be a new technology, a new design, a new procedure, a new planning method, a new policy analysis tool, or other innovation. Implementation projects are typically the result of a research project, but they may also result from a national research program, a project in another state, or other source. Typically, the Implementation Program focuses on the first applications within the Department.

The Implementation Program is funded separately from the research program. Annual funding for the Implementation Program has ranged between $3 million to $5 million since 1999. The FY 2011 budget is $3.5 million. In general, equipment and technology cannot be purchased as part of an implementation project.

Typically, implementation projects range between $20,000 to $100,000. As highlighted in the examples below, which focus on ITS and other technology-related implementation projects, many projects focus on training courses, workshops, and other related activities.

- **Training for Using Ground Penetrating Radar (GPR).** TTI researchers developed a GPR devise that is equipped to a vehicle, which is driven along a roadway to examine the pavement. The profile of the pavement is recorded for analysis in the laboratory. This project provided training for TxDOT personnel in the use of the GPR and analyzing the results.
- **Dynamic Message Sign (DMS) Message Design Manual Training.** This implementation project developed and conducted training on DMS messages. The DMS Message Design Manual was developed through a TxDOT research project. As part of the research project, TTI researchers had analyzed different text sizes and styles, message length, and message content. The project funded through the Implementation Program allowed researchers to develop and conduct training on the use of the manual with TxDOT district personnel responsible for operating Department's DMSs.
- **Traffic Signal Operations Handbook Workshop.** TTI researchers developed a TxDOT Traffic Signal Operations Handbook through the research program. This Implementation Program project provided funding for TTI researchers to develop and conduct workshops throughout the state providing training to TxDOT personnel on the use of the handbook.

Other Technology Transfer Activities

TTI researchers are also involved in a wide range of other technology transfer activities. Examples of these projects include developing and teaching National Highway Institute (NHI) and National Transit Institute (NTI) training courses, developing training sessions for other sponsors, and developing and hosting workshops and conferences for the Federal Highway Administration (FHWA), the U.S. DOT, and other sponsors. TTI researchers have developed videos, DVDs, and web postings to help disseminate the results of research projects. TTI researchers are also active in the development of standards for different organizations and participate actively in the Transportation Research Board (TRB) committees and other professional organizations.

Management and Operations

Roadside safety has always been a major focus of TTI research. The Institute has been a leader in the development of roadside safety devices. Patents have been secured in many of these devices over the years and licensing agreements have been executed with businesses to produce and sell different products. TTI researchers have also developed software applications which have been patented and licensed. An application using Bluetooth technology for detecting travel speeds is currently in the commercialization process.

The Institute receives assistance from the Texas A&M University System (TAMUS) Office of Technology Commercialization (OTC) in the commercialization and licensing process. The services offered by the OTC are described next. Royalties from the licensing agreements area is divided between TAMUS, TTI, and the researchers according to a predetermined formula. The Institute uses a portion of its share to support researcher-generated ideas for additional commercial applications.

Texas A&M University System Office of Technology Commercialization

The OTC was established in 1992 to provide a link between researchers in the TAMUS developing innovative technologies and applications and industry partners that can bring them to the marketplace as products. The mission of the OTC is:

> *"It is the mission of the OTC to encourage broad, practical application of System research for public benefit; to encourage and assist those associated with the System in the protection, licensing and commercialization of their discoveries; to ensure the equitable distribution of royalties and other monetary benefits resulting from the commercial application of intellectual property; and to see that commercialization activities benefit the research, education and outreach missions of the System into the future."*

The OTC assigns an individual to work with each of the System universities and agencies. The OTC staff member assigned to TTI works closely with researchers and administrative personnel in the intellectual property (IP) disclosure process and reviews the invention for potential commercialization. If an invention is accepted for management by the OTC, a commercialization plan is developed and executed.

To assist in communicating the various steps in the commercialization process, OTC personnel have conducted seminars for TTI researchers and staff as part of TTI's ongoing Research Development Seminars. Topics covered in the OTC sessions included indentifying what is what is intellectual property, how to protect or lose intellectual property rights, patents, copyrights, and trademarks, and the TAMUS policy and OTC procedures. Other sessions have provided more detail on the IP disclosure process and management, TTI procedures, and invention guidelines.

Lessons Learned

As discussed in this section of the report, TTI researchers are involved in a wide range of technology transfer activities. These activities include developing and conducting training sessions, developing and hosting conference and workshops, and disseminating research results through videos, DVDs, and websites. Researchers are also involved in commercialization and licensing of products and innovations. The following highlights a few of the lessons learned with these efforts.

- Training courses should not be static. Technology is changing rapidly, and there is an ongoing need to update and modify course content. Course instructors also need to maintain skills and an understanding of these changes and the capabilities of new technologies.

- Public agencies and public agency staff have limited time and resources to attend training. Turnover in public agencies also requires ongoing training activities.
- Public agencies are risk-aversive and funding-constrained. Working with the public sector to test and implement new technologies, methods, and policies is not easy. It takes time and effort to introduce new concepts, programs, policies, and technologies.
- The commercialization and licensing process takes time. There are many steps in the process. Providing ongoing training for researchers is needed to ensure they understand all the steps, as well as potential issues. The assistance of personnel with expertise in the IP, commercialization, and licensing process is key to moving products for research to the marketplace.

2. University Technology Transfer Program: Carnegie Mellon University (CMU), Project Olympus

Background

Carnegie Mellon University's Project Olympus was started about four years ago by Dr. Lenore Blum, a faculty member in the School of Computer Science. Dr. Blum noticed that unlike her previous experience working at UC-Berkeley, almost all of the computer science students at CMU were leaving the region after graduation because of the lack of an entrepreneurial environment to keep them in the area. This program was initially started in the School of Computer Science and later expanded to the whole CMU campus to help facilitate technology transfer by bridging the gap in getting the university's research transferred and commercialized into industry. Project Olympus accomplishes this by providing business and entrepreneurial support services for students and faculty.

T2 Policy

As a university sponsored program that aids the transfer of technology, Project Olympus follows the technology transfer policies of CMU. The technology transfer policy at CMU is primarily influenced by the Federal guidelines such as the Patent and Trademark Act Amendments of 1980 (or "Bayh-Dole Act"), which enabled universities and other organizations, such as small businesses and non-profits, retain title to inventions made under federally funded research. Industrial sponsored research arrangements also play a role in how technology is transferred from CMU to industry, but to a much smaller degree since this type research makes up a much smaller portion of the university's overall research budget.

T2 Mechanisms

This effort primarily utilizes three technology transfer mechanisms to help aid the technology transfer process at CMU. The first method, information exchanges, is focused on providing information and advice to aid faculty and students at CMU interested in entrepreneurship. The second mechanism, incubator space, provides an office environment away from the university where students and faculty can concentrate on their business. The third method involves technical assistance in the form of micro grants to faculty and students.

Information Exchanges

There are a number of formal and informal information exchanges that are utilized by Project Olympus to assist both students and faculty and "de-mystify" the technology transfer process. The primary means by which Project Olympus provides formal information exchange to students and faculty regarding technology transfer is through their website. On their website, Project Olympus staff has created a roadmap for technology transfer that helps to explain the technology transfer process to university faculty and students.

The informal information exchanges that are used by Project Olympus to aid in the transfer of technology at CMU are showcase forum events called "Show and Tell" for students and faculty. At their "Show and Tell" forum events, Project Olympus showcases "research, projects, spin-offs and community perspectives" to help "create a climate/culture and community that will enable talent and ideas to grow in the region".[26] In addition, they also sponsor a number of competitions on campus where students can compete to develop new innovations from early stage technology that may be the basis of a start-up company.

Project Olympus also has informal relationships with the state and local economic groups that fund and support entrepreneurs such as the Alpha Lab, Innovation Works, Technology Transfer Collaborative and the Pittsburgh Life Science Greenhouse to help assist students and faculty with whom they are working with in transferring their technology or helping to grow their start-up company. All of these groups provide a variety of services. For example, Project Olympus may refer one of their companies to Alpha Lab when it has outgrown the incubator space provided by CMU. Similarly, Project Olympus also refers their start-ups to Innovation Works, the Technology Transfer Collaborative, and the Pittsburgh Life Science Greenhouse for funding and entrepreneurial support.

Research Park (Incubator) Space

Incubator space owned by the university is leveraged by Project Olympus to help foster the transfer of technology to start-up companies formed by faculty and students. The advantage of having this incubator space available on campus is that faculty and students can remain more actively involved with the company due to its close proximity to their other activities, and this incubator environment allows these start-up companies that are located in this space to learn from each other.

Technical Assistance

Technical assistance is provided to students and faculty through the advice provided by Project Olympus staff and their micro grant funding support. Project Olympus staff work with faculty and staff to help them become more knowledgeable about the technology transfer and commercialization process from the earliest stages when an invention is generated from research to the later stages when the invention is formed into a platform product for a company.

Another way that Project Olympus provides technical assistance to help the technology transfer process at CMU is through micro grant funding support. These micro grants or proof of concept funding are called "PROBEs or ProBlem-Oriented Explorations" and supplied by Project Olympus to help assess the market potential of technology developed by students or faculty that they are working with at the university.[27]

Management and Operations

Project Olympus received seed funding from the Heinz Endowments Innovation Economy Program and uses a diverse mix of funding from university, corporate, and government sources to operate.[28] In the fall of 2010, it was one of three university efforts to receive funding from the Kauffman Foundation. Project Olympus has only two part-time staff members (Babs Carryer, Entrepreneurial Advisor and Kit Needham, Student Advisor). They work in partnership with the technology transfer office at Carnegie Mellon University to provide services to assist students and faculty with their technologies that could be the basis of a start-up company. Students and faculty may work with Project Olympus before, during, or after going to the technology transfer office at CMU:

[26] Project Olympus Website - http://www.olympus.cs.cmu.edu/events/

[27] Ibid.

[28] Ibid.

- **Pre-Tech Transfer assistance** – This may occur when students or faculty need advice to get a better understanding of the technology transfer process at the university, such as how to disclose an invention and when should an invention be protected.
- **Partnerships between Project Olympus and the CMU technology transfer office** – This can occur when a student or faculty member has met with the technology transfer office and decided to form a start-up company. Both the CMU technology transfer office and Project Olympus may work with the company to help facilitate the licensing of the technology. Another instance where this occurs is when they partner to have open office hours for students and faculty to drop-in and meet with both staff from the CMU technology transfer office and Project Olympus at the same time.
- **Post-Tech Transfer assistance** – This may occur after a start-up has received a license from CMU's technology transfer office. Project Olympus will work with the company to locate and prepare to present the company to funding sources such as Small Business Innovation Research (SBIR) grants, venture capital, and angel investments.

The metrics that Project Olympus uses to help measure the success of their efforts are the following factors:

- Number of projects (specifically, the number of student and faculty projects they work on)
- Amount of follow-up funding received towards commercialization by the companies that they assisted
- Human resources associated with companies assisted (such as the number of employees/consultants hired and the number of advisors and directors added)
- Stage of the company (i.e. how does the company advance as a result of their assistance).

In approximately four years, Project Olympus has worked with 40 projects – 20 student and 20 faculty projects. They have had 27 of these projects move forward to form a start-up company. Six of the start-ups have moved on to get into an incubator and one of their start-up companies have raised funding from outside investors.

Barriers to Success for T2

The barriers to success for Project Olympus are in two areas – staff resource constraints and funding. Currently, the diverse mix of funding only provides enough support for the staff to work part-time and a finite number or projects. In order to expand this effort where Project Olympus can supply more technical assistance, they indicated that they will need to increase the amount of funding needed to operate. An increase in operating funds for Project Olympus would allow them to bring on additional people to overcome their staffing constraints and allow them to provide more grant support to students and faculty. They are looking at a few NSF programs that may offer an opportunity to grow.

Future Outlook for T2

In the future, Project Olympus is looking at ways to increase the amount of support that they provide to students and faculty on campus. This support will be driven by the amount of funding that they receive in the future. Should they receive additional funding, there are three areas where they are looking at expanding: 1) bringing on 1-2 more entrepreneurs-in-residence as part of their staff; 2) establishing a pre-seed fund for projects; and 3) increasing the number of showcase forum events and competitions.

3. University Technology Transfer: Penn State University (PSU)

Background

Penn State University is an institution that performed $765 million in research in 2009. Since 2000, it has increased its Federal research by 95% to $445 million with funding coming from a broad number of agencies. From an industrial research standpoint, Penn State is ranked third nationally with $103.6 million in industry-sponsored research in 2009.[29]

While relationships with industry and other tech transfer partners develop at many levels at Penn State (including the Research Institutes and individual faculty levels), there are two key research support organizations, the Intellectual Property Office (IPO) and the Industrial Research Office (IRO), that are particularly engaged in technology transfer. Both of these groups report to the Vice President for Research and the Dean of the Graduate School through the Associate Vice President for Research and Technology Transfer. These two organizations also work with the University's research park office (Innovation Park and Research Commercialization) and the state supported Ben Franklin Technology Partners of Central and Northern Pennsylvania (BFTP/CNP) to advance technology development and commercialization.

In recent years, Penn State has complemented its historically strong research ties with industry and Federal agencies, with a pro-active technology commercialization program and a growing focus on entrepreneurial education and experiential learning activities.

T2 Policy

Technology transfer policies at PSU are primarily driven by the Federal guidelines and the individual contract arrangements with industry. From a Federal perspective, the Bayh–Dole Act helped to give universities including PSU title to inventions from research supported by Federal funds. As one the top universities conducting industrial sponsored research, PSU has formed a number of contractual arrangements with industrial partners that impact the transfer of technology.

In addition to transferring the knowledge of the university research to the private and public sector, the IPO is also responsible for helping to drive economic activity locally and nationally through commercial application of technology that is generated from PSU's research.[30]

- The IRO is charged with growing and creating lasting relationships more broadly between business and the Penn State research community that can lead to solutions that enhance their industry partners' competitive position in the global marketplace while also preserving PSU's role as a premiere educational and research institution.

T2 Mechanisms

Penn State uses a number of mechanisms – licenses, industry sponsored research, public sector technology transfer, and a research park to facilitate foster technology transfer. Some or all of these

[29] Annual Report of Research Activity, Fiscal Year 2009 - http://www.research.psu.edu/about/reports/annrep09.pdf

[30] PSU Strategic Plan, FY2009-2013 - http://www.research.psu.edu/about/documents/strategicplan.pdf

mechanisms may be used by clients in the private or public sector to help move university inventions into the marketplace.

Licenses

Licenses are one of the mechanisms that PSU uses to transfer its technology. Most of licenses that are issued by PSU are for patented university technology. Although, the volume of licenses is not very high at PSU (executing 11-20 licenses per year over the last five years), they view this area as a mechanism to complement some of their other technology transfer areas involving industrial sponsored research and research parks. Another reason for the low volume of licenses is that PSU maintains a small licensing staff and has only been formally involved with technology transfer in the last 10-15 years.

Industry Sponsored Research

Industry Sponsored Research is one of the key mechanisms that PSU utilizes for technology transfer. The mission of the Industrial Research Office is to help companies produce higher-quality, cost-effective services or products. The IRO accomplishes this goal by promoting faculty expertise and interdisciplinary research center capabilities through various channels, such as trade shows, a newsletter (called the IRON-Industrial Research Office Newsletter), the internet and direct marketing, which can be leveraged by industry to facilitate technology transfer. This office also has an extensive database of contacts from industry that they can use to target businesses interested in a particular field of study and help to identify potential partners for research and collaborative partnerships.

In addition, much of Penn State's industrial sponsored research is characterized by broad relationships with a large base of original equipment manufacturers (OEMs) and major corporations, as exhibited by the execution of over 200 active "master agreements" with these larger firms.

Public Sector Technology Transfer

Public sector technology transfer is another mechanism that PSU utilizes to move its university research into the marketplace. Through funding support from the Commonwealth of Pennsylvania, PSU operates one of the four regional entities for the Ben Franklin Technology Development Authority called the Ben Franklin Technology Partners of Central and Northern Pennsylvania. BFTP/CNP provides technology, management assistance, financial support and linkages to small business support resources for Pennsylvania-based, high technology companies in an effort to strengthen the state's economy. It is through these efforts that PSU helps to facilitate technology transfer by the public sector.[31]

Research Park

Penn State has a 118 acre research park called Innovation Park that provides companies with multiple real estate options, an incubator program, and business support services. Residents at the park have access to Penn State resources and the support services to transfer knowledge from PSU to the marketplace.

[31] Ibid.

Management and Operations

The Intellectual Property Office has 12 staff members to manage all of its major functions that are performed by this area – intellectual property and licensing, research park initiatives, industrial sponsored research and public sector technology transfer. These four units work together collaboratively to facilitate industry/university partnerships and to transfer technology into the marketplace.

For research that is generated at the university and that may need intellectual property protection such as a patent, copyright, or trademark, an invention disclosure form is completed by the inventor and submitted to the Intellectual Property Office. The IPO receives 200 new invention disclosures per year. A technology licensing officer (TLO) in the IPO is assigned to manage the disclosure and perform an initial technical review and assessment of the invention. Based upon this technical review, the TLO will determine whether or not the invention should be protected. If a decision is made to protect the invention, then an appropriate intellectual property strategy will be developed for the invention and a decision will be made on how to market the invention to potential licensees.

Some of the key metrics for the IPO at PSU is the following:

- Invention disclosures
- Patents
- Industrial Research Funding
- Licenses.

In its Industrial Research Office, Penn State has the basis for building additional capacity to undertake the above activities in a more focused and deliberative manner. The Director of the IRO reports to the Vice President for Research, and has a staff of approximately 10 professionals with industry related backgrounds.

The IRO is involved with facilitating contractual relationships for sponsored research and related activities. One unique method that this office has utilized to help facilitate technology transfer at PSU is development of a "master agreement" approach to assist with the development of ongoing, multi-project relationships with industry partners over a period time without the firms becoming encumbered by multiple licensing negotiations.

Barriers to Success for T2

Since a great deal of the technology transfer activities at PSU involves industry sponsored research, the difficult economic environment could cause industry to invest less on research and result in a slowdown in this area at PSU. The effects have already been shown in the last few years where industrial sponsored research slightly decreased at PSU in 2009.

Future Outlook for T2

The overall research budget continues to increase for PSU despite a slight decrease in the industrial sponsored research area. The university continues to get a variety of research funding in the Federal sector, which may offer growth in the number of technology transfer opportunities in the future.

As Penn State has moved toward an open innovation model that leverages its relationships with larger firms and working with smaller firms in advancing and transferring technology solutions to the marketplace, implementation of this model is being guided by the following principles:

- Leveraging Penn State's relationships with major corporations to directly build stronger partnerships with small, emerging technology firms
- Designing a talent and research agenda that brings in the perspective of industry
- Making awareness and outreach an important priority and function of a matrix-based organization, managed by the Industrial Research Office in partnership with others.

Penn State was recently successful in competing for one of three major energy innovation hubs that resulted in a $120 million in funding from U.S. Department of Energy over the next five years for the development of energy efficient building systems. This effort, based upon what is becoming a multi-party, multi-institutional clean energy campus at the Philadelphia Navy Yard, will include efforts to demonstrate and deploy new, integrated technology solutions. New models and approaches relevant to U.S. DOT's mission and technology transfer agenda could emerge from this major initiative.

Lessons Learned

Specific to technology transfer in the transportation arena, Penn State's perspective has been informed by the work of its own university transportation institute, the Thomas D. Larson Pennsylvania Transportation Institute (or the Larson Institute). The Larson Institute has three main research areas: transportation infrastructure; vehicle systems and safety; and transportation operations, with growing activities in hybrid and hydrogen vehicle research.

Based upon this experience, there are a number of barriers and issues that constrain and delay technology transfer and deployment.

- In the public domain, the state DOT directors are key, but have little incentive to take risks. The leading states that tend to be more open to new approaches include California, Washington, Texas, and Maryland.
- In managing university-industry partnerships and collaborations, it is important to have clear communication and understanding between academic and industry partners regarding timeframes, deliverables, outcomes, and expectations.

4. Federal Agency: NASA Glenn Research Center

Background

The NASA Glenn Research Center is one of the ten NASA field centers and located in Cleveland, Ohio. The main campus is located adjacent to Cleveland Hopkins Airport and its Plum Brook Station is located about 50 miles west of Cleveland near Sandusky, Ohio.[32] NASA Glenn research is focused on technology advancements in spaceflight systems development, aeropropulsion, space propulsion, power systems, nuclear systems, communications and human research.[33] The research budget is about $650 million annually.

Technology transfer has been and continues to be a main point of emphasis at NASA Glenn, but the focus is shifting from pushing out technology to bringing in technology to meet the needs of the agency. In addition, NASA Glenn is looking at opportunities to get more involved with economic development in the region.

T2 Policy

The technology transfer policy at NASA is centralized at NASA Headquarters. The Innovative Partnerships Program (IPP) has previously supplied a focused approach for technology transfer, but this effort has been integrated back into the Office of the Chief Technologist for a few reasons – 1) To help maximize the budget funding available for this area of focus; and 2) NASA has been fairly successful at pushing out their technology, but they have not done a very good job in transferring technologies back into their agency.

T2 Mechanisms

There are a number of key mechanisms – Space Act Agreements, technical assistance, and information exchanges that are used by NASA Glenn to leverage their knowledge, expertise and specialized facilities to help foster technology transfer. Licenses also can be considered a key mechanism overall for NASA, but not at all of NASA field centers.

Licenses

Licenses are not a key mechanism for NASA Glenn, but play a larger role at some of the other NASA field centers. In order for a license to be executed, NASA Glenn spends a lot of time looking for viable partners. NASA Glenn executes only about 1 license per year because most of the technology that is generated from their research is very early stage technology at a Technology Readiness Level (TRL) of 1, 2, or 3. The NASA field center that generates the most licenses, the Jet Propulsion Laboratory (JPL) at Caltech only produces 20-30 licenses per year. Reductions in the research budget have caused the overall number of NASA-wide licenses to decrease in FY2009 and it expected to have a similar impact in FY2010.

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[32] NASA Glenn Website - http://www.nasa.gov/home/index.html

[33] Ibid

Space Act Agreements

One of the key mechanisms at NASA Glenn is the Space Act Agreement (SAA). NASA Glenn executes about 125 SAAs annually. The majority of the Space Act Agreements are executed primarily to utilize the specialized facilities at NASA Glenn. The icing facility at NASA Glenn remains one of the most highly utilized facilities by the private sector. The pursuit and execution of SAAs continue to be a major activity driven by NASA GRC's desire to attract more new business.

Technical Assistance

NASA Glenn continues to provide some technical assistance to help facilitate tech transfer. Technical assistance occurs when NASA researchers utilize their know-how and expertise to help businesses solve a technical issue. Today, the number of hours of technical assistance provided to businesses by NASA GRC researchers is less than what it was in the past due to full cost accounting, which has made it more challenging for researchers to participate.

Information Exchanges

NASA Glenn utilizes both formal and informal information exchanges as mechanisms for technology transfer. There are a number of formal information exchange mechanisms that are used by NASA Glenn for technology transfer. First, NASA Glenn along with the other NASA field centers publish their technologies available for licensing in their "TechBriefs" publication and NASA technology that has been transferred to the businesses in the private sector are featured in their "Spin Off" publication. In addition, to distribution of these publications in print, NASA has a dedicated website where the public can search the database for a technology and read "TechBriefs" (http://www.techbriefs.com/) or "Spin Off" (http://www.sti.nasa.gov/tto/).

Another way formal information exchanges are used by NASA Glenn is through their technology transfer website (http://technology.grc.nasa.gov/index.shtm). NASA Glenn has made improvements to the site to make it easier for businesses find out how to work with their technology transfer office and find out about licensing opportunities. NASA Glenn is also looking at potentially working with DOE to use common technology definitions and cross-market technology in the energy area.

There are a number of informal information exchanges that NASA Glenn utilizes. NASA Glenn staff attends conferences and makes tradeshow appearances to communicate their knowledge and expertise with individuals in the private sector. NASA Glenn has become more targeted in recent years with the tradeshow events that they attend because it is expensive to participate.

Management and Operations

The Technology Transfer and Partnerships Office (TTPO) at NASA Glenn has an annual budget of $30 million. About $3 million of its annual funding is spent on technology transfer activities such as IP management (i.e. filing and maintaining patents), software releases, licenses and the awards program. The NASA Glenn TTPO is comprised of seven staff members plus the director. Most of the TTPO staff members are either business people with a technical sense or technical people with a business sense. The primary activities for the TTPO staff are focused on the Small Business Innovation Research (SBIR)/Small Business Technology Transfer (STTR) Program, award programs, Space Act Agreements, and review of new technology/invention disclosures.

The number of disclosures submitted to the TTPO office has fluctuated over recent years from a high of 220 to a low of 125. A few years ago, when the disclosure rate was low, NASA Glenn conducted a campaign to increase the disclosure rate by offering researchers training on the disclosure process.

Additional training and education may be conducted again this year to maintain and help increase the number of invention disclosures. Based upon their previous experience, addition training and education has resulted in 10% increase in invention disclosure volume.

The TTPO staff meets once per month to perform a technical evaluation of invention disclosures to determine whether or not the technology should move to the next stage to be assessed for market potential. NASA has hired an outside consultant, Fuentek, at $250k per year to perform the market assessments of their invention disclosures.

The primary metrics that are utilized by the NASA Glenn TTPO to evaluate the performance of the technology transfer operation are the following:

- Number of publications (i.e. success stories) in Spinoff magazine
- Number of invention disclosures received
- Patent applications
- Patents issued
- Partnerships formed.

Barriers to Success for T2

There are both external and internal barriers that may have an impact on the success of technology transfer at NASA Glenn. Currently, the most significant external barrier impacting technology transfer is the economy which is discouraging companies from taking the risk associated with licensing low TRL technology. The internal barrier impacting technology transfer is the inability to hire new staff. Success in technology transfer is based on the number of outreach attempts to market a technology by staff. Therefore, the more staff that you have, the better your ability is to perform market outreach that can lead to the transfer of the technology.

Future Outlook for T2

There future outlook for technology transfer at NASA Glenn is positive for a number of reasons. First, NASA Glenn has a robust research budget, which should lead to new growth opportunities for an increasing number of technologies being disclosed from this research. Second, NASA Glenn has hired a new patent attorney, and they are seeing an increase in patents applications from 7 patent applications per year to about 35-40 patent applications per year. This should lead to some new technology transfer opportunities as the patent portfolio continues to grow. Third, there is an increasing amount of attention on technology transfer from a NASA perspective because Federal funding is tight. This situation creates opportunities for those working in technology transfer to show how these activities can contribute to overcoming funding shortfalls, but it also presents a new challenge as universities are now competing with NASA Glenn and also trying to recognize this potential funding stream from technology transfer.

Lessons Learned

There are two lessons learned that the NASA Glenn TTPO has gained from their technology transfer experience. The first lesson learned is to benchmark the technology transfer operation against other organizations. This will help provide ideas to make continuous improvements. The second lesson learned is to focus the mission of the organization. It is easy for technology transfer offices to lose their focus since they are presented with so many opportunities, but these offices need to maintain their focus on the highest potential technologies and not the small ones to collect the most impactful outcomes.

5. Federally Funded Research and Development Center: Software Engineering Institute (SEI)

Background

The Software Engineering Institute is a Department of Defense (DOD) Federally Funded Research and Development Center (FFRDC) that has been based at Carnegie Mellon University since 1984. SEI helps organizations in government, industry, and academia to acquire the correct software or improve their software engineering capabilities to meet their system needs through the following activities[34]:

- Conducting research to discover solutions to software engineering problems
- Identifying technology solutions
- Testing and refining solutions through pilot programs to help organizations solve their problems
- Disseminating widely proven solutions through training, licensing, and publication of best practices.[35]

Technology transfer at SEI differs from the CMU technology transfer office because they are looking at broad transition. Over 60% of the mission for SEI is to transfer their technology into broad adoption to raise the state of the practice.

T2 Policy

Technology transfer policy at SEI is guided by the Federal government regulations and terms in the contract agreement that CMU executed with sponsoring agency, DOD. Oversight for their technology transfer activities is provided by the Office of the Secretary of DOD.

T2 Mechanisms

There are two primary mechanisms that SEI uses to facilitate technology transfer – 1) information exchanges and 2) licensing.

Information Exchanges

SEI utilizes a variety of formal and informal information exchanges to help transfer their technology. The primary method used by SEI to transfer their technology is through formal information exchanges by their partnership network. In 1999, SEI began to focus on taking their repeatable software technology from their research (such as the capability maturity model) to help create a new source of revenue for the organization. They started to package their technology into a standalone product/service, or bundle it into a suite of products/services. To aid with the distribution of these products/services, they formed a partnership network with 10 organizations or “partners” that has evolved to 450 partners today with 50% of these organizations outside of the United States. SEI partners are organizations that are tested, monitored, and licensed by the SEI to provide their courses

[34] SEI Website - http://www.sei.cmu.edu/

[35] Ibid

and services."[36] Over 90% of SEI's basic courses for their products/services are taught by partners to train as well as certify others in the use of their products. Asia and India have traditionally been where many of their partner organizations are located outside the U.S., but most of the current growth is in Eastern Europe, Latin America and South Africa with a future trend towards Western Europe. Since SEI is providing products and services, they do not run into export issues.

Additionally, SEI looks to their partners as a major resource to help bring them improvements for their software products and services. Contributions from 250 individuals in their partner community have aided the introduction of a new version of the CMMI suite. These individuals were able to form subteams that used a variety of communication methods including face-to-face meetings, change control boards, and virtual meetings to collect information and work on improving the product.

Formal information exchange occurs in the form of course administration at the advanced levels. SEI utilizes in-house staff to deliver advanced course offerings, while relying on SEI network partners to deliver the basic course offerings. SEI has elected this approach for course delivery because they do not want to be in competition with their partners. SEI also offers instructor-based learning and eLearning online courses and webinars for their customers.

Some of the informal information exchange methods that are used by SEI to aid in the transfer of technology are publications/reports/presentations, tradeshow appearances, and conference participation. SEI produces a number of publications/reports/presentations that are posted on their website to help aid in the transfer of their technology to customers. In addition, SEI staff participates in tradeshows and industry-related conferences to help facilitate the transfer of their technology.

Licensing

The second mechanism that is used by SEI to help foster technology transfer is the licensing. SEI partners that provide courses and services must pay a license fee for the course content as well as a certification fee to enable instructors from their respective organization to teach a course. In addition, the license helps to ensure that the partner organizations will follow SEI guidelines to certify their instructors delivering the courses. Most individuals will need to be recertified every 1-3 years. SEI has 47 transitionable products and services that are available for licensing.

Management and Operations

In addition to licensing revenue, a variety of funding sources is used to support the management and operations of SEI. Only a small portion of its revenue comes from DOD line funding for the FFRDC. The other sources of revenue are the following:

- Research and development outside of the DOD line funding (involving work with other Federal agencies)
- Commercial and international funding (i.e. services to commercial and international customers)
- Ancillary services (such as education and training)
- Work with DOD on contracts
- System integration consulting
- University-related projects.

[36] Ibid

At SEI, the technology transfer efforts are housed within the program that does all of the business development and communications. This group consists of the director's office, program development and transition, and industry and international efforts. SEI has internal resources that are responsible for marketing their products to key customers. There is a decentralized structure with respect to transitioning their technology at SEI where everyone is charged with this responsibility as part of their work with clients.

The technology transfer activities at SEI are measured by transition impact. They expect a certain amount of growth in partners resulting in an increase in revenue growth from this customer segment. In addition, they look at the partnership impact such as the number of appraisals performed by partners and where the transition of their technology is growing globally as well as regionally.

Barriers to Success for T2

SEI has two barriers that may impact the success of transitioning their technologies to customers. The first barrier is competition in the marketplace. There are a number various sized (i.e. small, medium and large) players that compete with SEI. The second barrier is that it is difficult to make business solutions that will satisfy everyone. SEI has formed an advisory board consisting of members from its partner network to help get feedback and conduct pilots in an effort to generate solutions that will reach a larger audience. Representation is based upon the size of the organization in the marketplace. The board is comprised of eight representatives, one chair, one SEI representative and one non-voting member. With the exception of the SEI representative, the advisory board members serve a two-year term with four members alternating every other year.

Future Outlook for T2

The future outlook for SEI with respect to technology transfer will focus on making it easier to license its products. SEI has 47 products and many complement each other. In the future to help facilitate the licensing of their products and create administration efficiencies, they are looking at creating a universal license agreement that will bundle their products and services to create universal product or service suites and make the costs more affordable for some customers.

6. *Industry: Maryland Technology Development Corporation (TEDCO)*

Background

Initially established in 1998 as specialized technology transfer arm of the State of Maryland Department of Business and Economic Development, the Maryland Technology Development Corporation has evolved into an independent organization that helps to facilitate transfer and commercialization of technology from state, Federal and commercial institutions. TEDCO accomplishes its work by providing indirect support as an intermediary or direct technical assistance and funding to help small businesses leverage the technology and the technology related assistance at state and Federal institutions. TEDCO also plays a role in the spin-out and the spin-in of technologies to small businesses for their clients.

T2 Policy

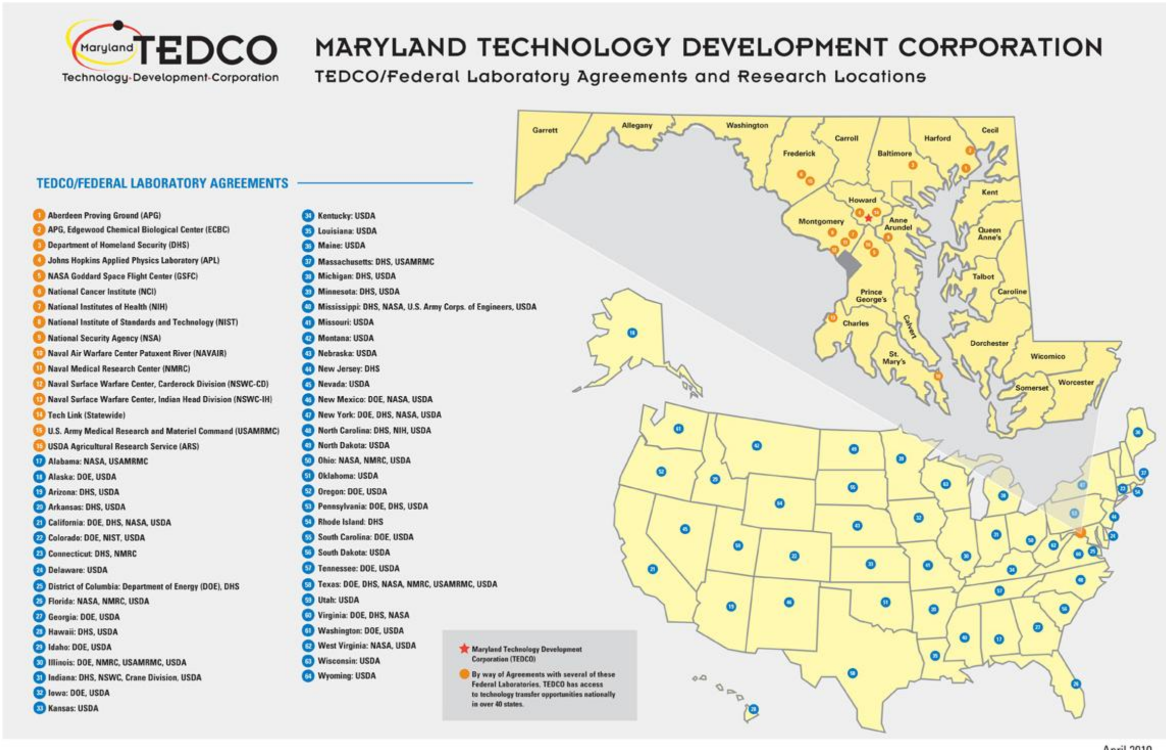
The technology transfer policy for TEDCO is based upon the guidelines of their client. For example, for clients in the Federal sector, TEDCO's policy will be directed by numerous Federal laws and policy (~17 laws) that have be put into place to facilitate technology transfer, and the terms in the partnership intermediary agreement. The terms in the partnership intermediary agreement may define the specific types of activities, such as marketing outreach, partnership development, and other efforts that TEDCO will conduct for the client. For clients at the state level, TEDCO's policy is based upon the contractual arrangements set by the funding organization.

T2 Mechanisms

Given its proximity to a large number of Federal labs in the Washington DC area, TEDCO has been a leader among state technology development programs in working with Federal labs to facilitate relationships and technology transfer activities between the labs and small firms.

A key technology transfer mechanism that TEDCO utilizes to facilitate technology transfer in the public sector is functioning as a partnership intermediary for Federal, state and international institutions. For its Federal lab programs, TEDCO has developed agreements with 17 Federal labs (See Figure C-2 below). In some cases, the labs will pay TEDCO to help it engage with a larger base of small firms beyond the state. In other cases, when such work is underwritten by the state of Maryland, TEDCO focuses on linking small, in-state firms with the labs.

Figure C-2: Maryland TEDCO Lab Agreements and Research Locations



Public Sector Technology Transfer

In its role as a partnership intermediary, TEDCO helps Federal, state and international organizations conduct technology transfer with small businesses. TEDCO has different models based upon the needs of the client. Some of the activities that TEDCO may perform in its partnership intermediary role for Federal clients are the following:

- Cooperative Research and Development Agreement (CRADA) Partnership Development
- Locating and identifying expertise within the agency that can be leveraged by industry
- Grant support
  - Grant support up to $75k to support the transfer of technology, or technology development by a small business that falls within the scope of the Federal client
- Marketing outreach
  - Showcase events – done for a Federal lab or academic institution
  - Public relations and marketing communications for the Federal agency.

For state clients, TEDCO also functions as a partnership intermediary using a variety of models. The majority of their support is seed funding and business assistance to help foster the transfer and commercialization of technology by emerging businesses in Maryland. An example of some of the activities that TEDCO may conduct for state clients are the following:

- Maryland Technology Transfer and Commercialization Fund
  - Grant funding up to $75k to help initiate technology transfer between a Maryland-based company and a Federal or academic institution in Maryland.

- University Technology Development Fund
  - Proof of concept and patent research funding for up to $50k to help advance university-related technology in Maryland and reduce the technical risk for potential licensees.
- Power of 10
  - An event where TEDCO takes the top 10 small companies, provide them with coaching and arrange for them to present to angel investors for funding support.

For its state funding programs, TEDCO receives royalty-based pay that is based on the revenue of the company over a five year period in exchange for funding the company, but there is no payback for the Federal funding program.

Management and Operations

TEDCO receives funding from a variety of sources (state, Federal, and industry) to support its operations. The organization is governed by a 15 member board with representatives from the private and public sectors. TEDCO has a director of technology transfer that helps to lead efforts in this area, but it also has other staff members, who are primarily responsible for its Federal, state, and other program efforts as a partnership intermediary.

TEDCO utilizes different measurements based on the type of program (i.e. Federal or state) to help measure the success of it technology transfer efforts. Since there is no payback to TEDCO for the Federal programs, there is a tilt toward measuring how they meet Federal needs by tracking the number of collaborative relationships facilitated by TEDCO. From a state program standpoint, TEDCO has a financial stake in these efforts. This situation has caused TEDCO to look at measuring the state program efforts from a commercialization standpoint by tracking the follow-up funding received by emerging businesses that received assistance from TEDCO.

Barriers to Success for T2

TEDCO has established many of its programs for clients in state, Federal and commercial sectors because it believes that that lack of business acumen found in these sectors is the biggest obstacle in successfully facilitating technology transfer in these areas. By functioning as a partnership intermediary, TEDCO believes that it can bridge this gap where they help clients in the state, Federal and commercial sectors collaborate with businesses to facilitate technology transfer.

Future Outlook for T2

The future for technology transfer looks bright for TEDCO. In addition, to the growth with state and local clients, they are expanding their partnership intermediary efforts to assist with technology transfer with clients internationally and in industry. For example, Johnson & Johnson (J&J) is looking at non-technical proposals from businesses screened by TEDCO that may be working in areas of interest to J&J to provide advice and potentially co-invest with TEDCO to further develop the technology.

7. Industry: yet2.com

Background

Founded in 1999, yet2.com is a privately funded technology broker that enables interactive technology transfer between corporations, academic institutions, national labs, technology brokers, and individual inventors worldwide. This company has been capitalized by corporate investment, private investment and venture capital.

Yet2.com started as an online marketplace to enable parties to buy and sell technologies, and, at the time, was among the 30 internet portals. Since that time, there has been considerable attrition in this space because many of the underlying business models have not proven to be economically sustainable. As it has grown with its customers, yet2.com has developed other services, including a consulting practice in which it serves as an outsourced scout, broker, or other resource for its clients – many of whom have downsized their internal capacities during the recession. Conversely, yet2.com's business has grown during this period and significantly moved towards open innovation support for large corporations and Federal agencies.

T2 Policy

Through its practice, the firm has found that there are certain criteria that need to be met for a successful technology transfer transaction. These include:

- Defining a clear value proposition as to why a user or customer would be interested in a new technology to solve a problem – who cares and why?
- Finding a technology that is at a stage of development –even if it has not been applied to the particular problem at hand – whereby it is ready for application.
- Is there sufficient IP protection to ensure that the user will have the freedom to operate with the licensed or acquired technology in the space or area of application required?

This firm is focused on enabling and facilitating transactions, although it benefits from its knowledge and activities in a broader range of activities related to technology transfer. A knowledge base to date of over 11,000 firms that includes many small innovative firms enables it to more effectively serve its consulting and patent selling/buying clients.

T2 Mechanisms

The primary means that yet2.com utilizes to facilitate technology transfer is through a formal information exchange.

Information Exchanges

Through its online marketplace, the company provides a formal information exchange where the online user-driven search and indexing services helps to connect businesses and individuals who want to sell, license, buy and trade technology over the Internet through the use of questionnaires which facilitate anonymous transactions between interested parties. Products and services are sold to multiple industries.

After starting with the first component, yet2.com has developed other business lines within its larger mission which leverage its online marketplace.

Yet2.com's service offering has two components:

- A "passive" distribution or broadcasting activity with over 120,000 users worldwide and 200 plus partners
- A professional services component that builds on the above information and the firm's "know-how" – this expertise is generally delivered through consulting engagements with major firms, small firms, and Federal agencies to enable these organizations to effectively monetize their technologies or find a technology solution.

In addition, the company is involved in patent brokering activities by providing formal information exchange services that enable firms to sell and anonymously buy patents and patent portfolios using the online Internet marketplace and direct professional connections. Yet2.com's client list does not include non-practicing entities. A third formal information exchange business area that it has also developed is a venture financing arm in which it provides funding for selected business ventures in which it sees an upside potential.

Management and Operations

The firm is headquartered in Needham Massachusetts, and has offices in Delaware, Nevada, Tokyo, and Liverpool, UK. Staffing is at a total of 20 employees with additional partners and associates.

Barriers to Success for T2

From a Federal perspective, the firm has found that sometimes the resource to solve a problem exists in another Federal agency, but the barrier to successful linkages can be the lack of budgetary or other mechanisms to foster the utilization of that Federal resource.

Future Outlook for T2

Yet2.com's experience includes working with Federal agencies and national labs, including NASA, Air Force Research Lab (AFRL), and Oak Ridge National Laboratory (ORNL). While the dynamics for a Federal procurement agency, such as DOD or NASA, is different than for a procurement organization in the private sector, the firm has found it is important to define a problem effectively before seeking potential solutions online using the Internet. The White House's recent effort to use the Internet to solicit solutions to government problems through Challenge.gov is an example of crowdsourcing through the Internet where they reached out to the public for solutions to some of the nation's most urgent challenges. While this approach has some initial promise in facilitating the search for ideas, it is unlikely to produce major changes or breakthroughs without initiatives and institutional changes. Educational awareness is an important initial part of the process. Yet2.com believes that there will continue to be opportunities in the future for their online marketplace, or their other information exchange methods to facilitate technology transfer when utilized under the right circumstances.

Lessons Learned

From its experience, yet2.com has found that, notwithstanding the initial attractiveness of online mechanisms enabled through the Internet, technology transfer effectively happens through a process of the technology seeker defining its requirements in such a way that enables them to look beyond the known and obvious technologies currently being applied in the seeker's industry. In addition, the process is often based upon human interaction and relationships that are built upon both knowledge of the functional requirements and a clear performance specification of the problem being addressed. Thus, technology solutions are often found in unrelated industries and places.

Also, in working with Federal agencies, the firm has found that it important to select pilot projects that have some near-term chances of success in order to build capacity and momentum going forward.

APPENDIX D: List of Acronyms

AASHTO	American Association of State and Highway Transportation Officials
AFRL	Air Force Research Laboratory
ARS	Agricultural Research Services
ARDEC	Armament Research Development and Engineering Center
AURP	Association of University Research Parks
AUTM	Association of University Technology Managers
AzTE	Arizona Science and Technology Enterprises LLC
BARC	Beltsville Agricultural Research Center
BFTP/CNP	Ben Franklin Technology Partners of Central and Northern Pennsylvania
BIO	Biotechnology Industry Organization
Caltech	California Institute of Technology
CMMI	Capability Maturity Model Integration
CMU	Carnegie Mellon University
CRADA	Cooperative Research and Development Agreement
DHS	Department of Homeland Security
DMS	Dynamic Message Sign
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
EPRI	Electric Power and Research Institute
EUL	Enhanced Use Lease
FFRDC	Federally Funded Research and Development Centers
FHWA	Federal Highway Administration
FLC	Federal Laboratory Consortium
FTA	Federal Transit Administration
GAO	Government Accounting Office
GPR	Ground Penetrating Radar
GRA	Georgia Research Alliance
GRC	Glenn Research Center
GTRC	Georgia Technology Research Corporation
HHS	Health and Human Services
ILP	Industrial Liaison Program
IP	Intellectual Property
IPA	Institutional Patent Agreement
IPO	Intellectual Property Office
IPP	Innovative Partnerships Program
IRO	Industrial Relations Office
IRON	Industrial Research Office Newsletter
ITE	Institute of Transportation Engineers
ITS	Intelligence Transportation Systems
ITS JPO	Intelligence Transportation Systems Joint Program Office
J&J	Johnson & Johnson Co.
JPL	Jet Propulsion Laboratory
JPO	Joint Program Office
LES	Licensing Executives Society
LTAP	Local Technology Assistance Program
MEP	Manufacturing Extension Program

MIT	Massachusetts Institute of Technology
MOU	Memorandum of Understanding
MTA	Material Transfer Agreement
NASA	National Aeronautical and Space Administration
NETL	National Energy Technology Laboratory
NHI	National Highway Institute
NIH	National Institute of Health
NIST	National Institute for Science and Technology
NREL	National Renewable Energy Laboratory
NSF	National Science Foundation
NTI	National Transit Institute
ONR	Office of Naval Research
ONRL	Oak Ridge National Laboratory
ORTA	Office of Research and Technology Applications
OTC	Office of Technology Commercialization
OTL	Office of Technology Licensing
OTT	Office of Technology Transfer
PA	Patent Advisor
P&G	Proctor & Gamble
PI	Principal Investigator
PIA	Partnership Intermediary Agreement
PNNL	Pacific Northwest Laboratory
PROBE	ProBlem-Oriented Explorations
PSU	Penn State University
R&D	Research and Development
RITA	Research and Innovative Technology Administration
ROI	Return on Investment
RTI	Research and Technology Implementation
SAA	Space Act Agreement
SBIR	Small Business Innovation Research
SEI	Software Engineering Institute
SEMATECH	Semiconductor Manufacturing Technologies
S&L	State and Local
SSL	Solid State Lighting
STTR	Small Business Technology Transfer
SUA	Software Use Agreement
SWUTC	Southwest University Transportation Center
T2 or TT	Technology Transfer
TAMUS	Texas A&M University System
TAP	Transition Assistance Program
TEC	Transportation Economics Center
TEDCO	Technology Development Corporation
TIG	Technology Implementation Group
TIPS	Technology Insertion Program for Savings
TLO	Technology Licensing Office
TPP	Technology Partnership Practice
TRB	Transportation Research Board
TRIS	Transportation Research Information Services
TRL	Technology Readiness Level
TTAP	Tribal Technical Assistance Program
TTI	Texas Transportation Institute
TTO	Technology Transfer Office

TTPO	Technology Transfer and Partnerships Office
TVC	Technology Ventures Corporation
TxDOT	Texas Department of Transportation
UNC	University of North Carolina
US	United States
USDA	U.S. Department of Agriculture
U.S. DOT	United States Department of Transportation
U.S. PTO	United States Patent and Trademark Office
UTC	University Transportation Center
UTCM	University Transportation Center for Mobility
WARF	Wisconsin Alumni Research Foundation
WRF	Washington Research Foundation
WFO	Work for Others

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