

Guide to Accelerating New Technology Adoption through Directed Technology Transfer

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP REPORT 768

**Guide to Accelerating
New Technology Adoption
through Directed
Technology Transfer**

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

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FOREWORD

By Andrew C. Lemer

Staff Officer

Transportation Research Board

NCHRP 768: Guide to Accelerating New Technology Adoption through Directed Technology Transfer presents a framework and guidance on how to use technology transfer to guide and accelerate innovation within a state department of transportation (DOT) or other such agency. The guidance will be helpful for agency personnel with any level of experience in adoption of new technology. The guide includes illustrative examples of innovations in organization and policy as well as design, materials, and operations.

State departments of transportation (DOTs) and other organizations responsible for development and management of our surface transportation system seek to enhance both system performance and their capabilities to make improvements. Innovation through adoption of new technology is an important way to make improvements. Accelerating the rate of innovation within and among agencies can bring benefits to the public that relies on the transportation system as well as to the agency in pursuit of its mission.

The challenges in adopting new technology, however, are widely acknowledged and persistent; and much has been written about the innovation process. One of the ways that organizations and professionals seek to meet these challenges is through technology transfer (T²).

T² itself has been the subject of much study and its literature is vast. The term can have different meaning in different contexts. In this guide, T² is viewed broadly as a way that ideas, knowledge, practices, processes, or techniques are shared between and within organizations. This report addresses *guided T²*, a purposeful activity involving at least two parties engaged in a conscious effort to exchange information intended to encourage adoption and use—deployment—of a new idea.

The objective of NCHRP Project 20-93, Development of a Guide for Transportation Technology Transfer was to develop a guide that provides methodologies, case examples, and techniques that facilitate transportation T². The goal underlying this objective is accelerating the rates of innovation within and among transportation agencies. A research team led by Pennoni Associates, Inc., Philadelphia, PA, conducted the research.

The research team started with a review of literature on current T² practices. The team identified case studies or examples to illustrate how key steps in the technology adoption process have been successfully taken in situations typical of those likely to be encountered in transportation agencies. The team then constructed a highly structured set of guidance components to support agency staff efforts to use guided T² to encourage adoption of new ideas within their agencies.

This document is written to assist DOT staff and others working to encourage innovation through the adoption and deployment of new ideas, techniques, or tools. Even when opportunities for adoption may not be immediate, the guided T² activities addressed in this guide can play a productive role in building awareness of the new ideas and practices that can improve system or agency performance when the opportunity arises.

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Development of the guide utilized the resources and expertise of many professionals from around the country. Input was received from numerous individuals during informal meetings with TRB’s Technology Transfer Committee, the AASHTO Research Advisory Committee (RAC), the National Transportation Training Director (NTTD) conference, and the National Local Technical Assistance Program (LTAP)/ Tribal Technical Assistance Program (TTAP) meeting. The research team would like to specifically acknowledge those who contributed to this guide through an in-person interview, a telephone interview, or by responding to a survey. These individuals and organizations provided material, information for case examples, and input and comments during the development of the guide:

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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.


SUMMARY

Guide to Accelerating New Technology Adoption through Directed Technology Transfer

The viability of the nation's transportation system depends upon continuing innovation that can make the system safer, last longer, and operate more efficiently. State transportation agencies, responsible for development and operation of major elements of this system, play an important role in this innovation. Technology transfer (T²) is an integral function in the process that advances innovation and brings new ideas to transportation organizations.

In this guide, T² refers to a way that ideas, knowledge, practices, products, processes, or techniques are shared between and within organizations. As a purposeful action, T² involves at least two parties, a source and a recipient, engaged in the sharing of knowledge about new practices, products, processes, or other elements of technology. T² may be initiated by the source, the recipient, mutually by both, or by a third party acting to facilitate the sharing.

Among the essential factors for effective T² highlighted in this definition are the following:

- The *technology* being transferred is broadly defined. It can be tangible (hardware and software) or intangible (knowledge and practices—*why* and *how* to do something novel).
- At least two parties are involved in the transfer, a source and a recipient.
- T² is usually purposeful, directed at solving a problem or gaining an advantage, but it can also be an organic process based in culture change and evolution.

Individuals with primary responsibilities for meeting the challenge of transportation T² work in varied settings, including state departments of transportation (DOTs); other state agencies such as departments of motor vehicles, state and local law enforcement, and public works agencies; and federal agencies such as the U.S. DOT through the FHWA, Office of the Assistant Secretary for Research and Technology (formerly RITA), and additional agencies within U.S. DOT. Others who play key roles in transferring technologies to transportation agencies include the staff of Local Technical Assistance Programs (LTAPs or T² Centers), Tribal Technical Assistance Programs (TTAPs), University Transportation Centers (UTCs), private sector companies, and universities. These non-governmental agencies often partner with DOTs, enhancing transportation T² efforts through the introduction of new technologies and broadening the audience for dissemination and deployment. This guide is intended for anyone who has an interest in applying innovations to solve transportation sector problems.

Why Use This Guide?

At transportation organizations and elsewhere, a well-planned and systematic T² process can reduce the time needed to deploy an innovation. This is important because the more quickly that practitioners see the benefits of innovative ideas, practices, and

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products, the faster they are to adopt them. This guide focuses on a purposefully planned and systematic T² process called *guided T²*. This guide is meant to assist transportation practitioners in accelerating the adoption of new technology through organizing a guided T² effort. The guide will help educate practitioners about guided T² and enable them to better understand the role of guided T² in the broader process of innovation deployment.

Whether the user is a state DOT employee, another public agency employee engaged with transportation, a public or private sector professional specifically responsible for encouraging T², or a researcher outside of a DOT who produces new ideas that may eventually be suitable for application, this guide has something that can help.

The guide is designed to assist practitioners with a range of experience with T²—from those just starting out to those more experienced in T². Information is organized for three general classes of users who engage in T² activities:

1. **Novice.** This person is new to T² and is unfamiliar with the components of guided T². Novices start with little knowledge of T² other than that they have a product that they want to move toward implementation and deployment. This guide will provide the novice with necessary background information and a description of how to accelerate the adoption of innovation through a guided T² effort.
2. **Experienced T² practitioner.** This person is familiar with guided T² and has worked with some or all of the guided T² components before. The guide will provide the experienced T² practitioner the opportunity to gather additional background knowledge and to ensure that the application of their guided T² process is thorough and complete. The arrangement of the guided T² components in this guide will allow the experienced T² practitioner to discover and fill gaps in their process without reviewing knowledge they already possess.
3. **Experienced T² practitioner with a particular challenge to address.** This person is familiar with the guided T² process and its components and can use this guide to address a particular T² issue or issues.

These user groups are discussed in detail in Chapter 1.

A guided T² effort is built on 10 key components that follow from the T² definition provided above. Together, the 10 components provide practitioners with a “roadmap” through the guided T² process. The 10 components are the following:

- Address societal and legal issues
- Have an effective champion
- Engage decision makers
- Develop a T² plan
- Identify, inform, and engage stakeholders
- Identify and secure resources
- Conduct demonstrations/showcases
- Educate, inform, and provide technical assistance
- Evaluate progress
- Reach deployment decision

These components, their interplay in determining T² effectiveness, and how the practitioner can anticipate and manage them are the focus of this guide. For each component, the guide highlights where barriers to innovation may be encountered and provides suggestions for how those barriers can be avoided or overcome with effective guided T².

How Is This Guide Organized?

Chapter 1 of this guide provides background on innovation adoption and T²; introduces “the Innovation Adoption Process,” guided T², and its 10 components; and explores how different users can approach the remaining chapters of the guide.

Chapters 2 through 11 of the guide are focused on assisting users with the guided T² phase of the Innovation Adoption Process. Each chapter details one of 10 components of guided T²:

- Chapter 2: Address Societal and Legal Issues
- Chapter 3: Have an Effective Champion
- Chapter 4: Engage Decision Makers
- Chapter 5: Develop a T² Plan
- Chapter 6: Identify, Inform, and Engage Stakeholders
- Chapter 7: Identify and Secure Resources
- Chapter 8: Conduct Demonstrations/Showcases
- Chapter 9: Educate, Inform, and Provide Technical Assistance
- Chapter 10: Evaluate Progress
- Chapter 11: Reach Deployment Decision

The guide also includes a glossary and two appendices:

- Appendix A: Guided T² Checklist provides a checklist of the 10 components of guided T² for the practitioner to use in tracking progress through a guided T² effort.
- Appendix B: Suggested Readings on T² provides suggested readings to gain further knowledge and understanding of T².

How Do Users Get Started?

All users will likely benefit from reading each chapter in this guide. The first step for practitioners is to decide what level of practitioner they are: novice, experienced T² practitioner, or experienced T² practitioner with a particular challenge to address.

Novices should start with Chapter 1 of this guide to learn about the basics of guided T² and to understand the role of guided T² in accelerating innovation adoption.

Experienced T² practitioners may want to start with Chapter 1 of this guide to understand the role of guided T² in accelerating innovation adoption. An experienced T² practitioner may not need as much information as a novice, but may want to review some information to ensure that his/her particular T² effort is thorough and complete. The guide uses questions to lead experienced T² practitioners to information that they may need.

Experienced T² practitioners with a particular challenge to address may turn directly to Chapters 2 through 11 of this guide to delve into the guided T² component(s) most relevant to their particular challenge.



CHAPTER 1

Background

State departments of transportation (DOTs) and other organizations responsible for development and management of the surface transportation system seek to enhance both system performance and their capabilities to make improvements. Innovation—adoption of new ideas, products, specifications, and methods, that is, new technology—is an important way to make improvements; to make the system safer, more efficient, more durable, and less likely to have unintended adverse consequences; and to help the DOTs do their jobs faster and more effectively.

New technology becomes available from many sources. For example, research may produce new understanding as well as new materials and methods that can be put to good use. Transportation system practitioners or users may have insights that can be applied to change how the system functions. Innovation occurs when new technology is actually adopted, put into practice to produce benefits.

Adopting new technology is widely acknowledged to be a challenging and sometimes risky business, however. Innovation involves change. Applying new ideas may not work out as planned. An individual's attitudes, preconceptions, and beliefs often have to change in order to accept new ideas, and these kinds of changes don't always happen easily. In organizations, individual response to change can range from those who embrace change with excitement to those who resist change as long as possible. Indeed, one of the many factors affecting the rate of change in an organization is how the adopter of an innovation behaves, as described by Everett M. Rogers in his highly regarded work, *Diffusion of Innovations, 5th Edition* (2003). There are predictable actions that emerge from categories of organizations and individuals as they perform the change required in adopting an innovation. Figure 1-1, adapted from *Diffusion of Innovations*, shows the distribution of innovation adopter categories.

Rogers (2003) describes these adopter categories as follows:

- **Innovators.** Some organizations and individuals may immediately see the benefits of new ideas and have a willingness to accept the risk which comes with being “the first.” These innovators may have an organizational culture that routinely embraces innovation or may simply have a strong champion for making a particular change.
- **Early adopters.** Not far behind the innovators are those who may have a strong interest in an innovation, but who want to look at it more closely before committing to deployment. These early adopters feel the “pull” to bring new ideas and improvements into their organization, are respected opinion leaders, and have the business processes and coordination mechanisms that can make change happen.
- **Early majority.** As more and more people in an organization begin deploying an innovation, the momentum builds for others to join in. This early majority is seldom made up of opinion leaders, but this group has a great deal of interconnectedness with peers. The early majority

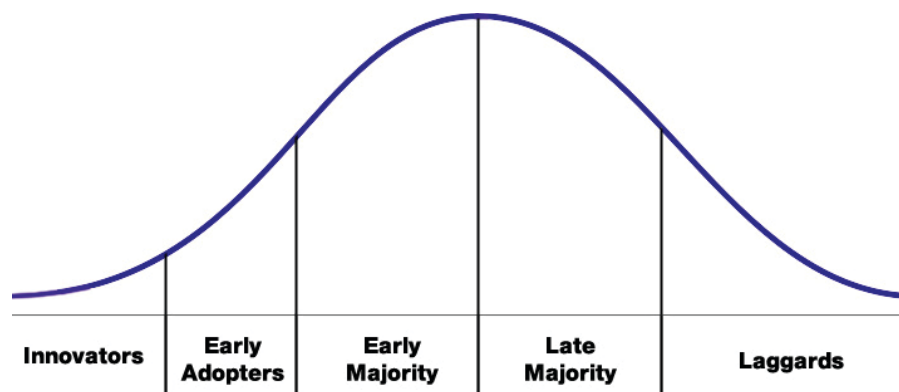


Figure 1-1. Adopter categories on the basis of innovativeness (Adapted from Rogers, 2003).

helps to advance their colleagues from wondering whether they will deploy the change to asking themselves and others why they haven't deployed the change. This group ultimately brings the majority into the practice.

- **Late majority.** These organizations and individuals are likely to be more risk averse and may want to wait until the innovation has been accepted by the majority of their peers. The strategy for reaching these organizations and individuals may require a heavy “push” in which any specific barriers standing in the way of deployment are removed.
- **Laggards.** These individuals and organizations are the last to adopt new ideas or innovations. In some organizations there may be a strong aversion to risk, reinforced by an equally strong inclination to continue doing things the way that they have always been done. Sometimes the resistance posed by persistent laggards is overcome only when the change is made mandatory through new standards or regulatory policy.

The process underlying Figure 1-1, the diffusion of a new technology into widespread practice, often occurs without focused effort or planned and coordinated action. News reports, professional publications, and word of mouth inform potential adopters about the new product or practice and some of the knowledge recipients will try it out. The information that is shared may be incomplete or even erroneous, thereby obscuring the true benefits of the innovation and discouraging further diffusion. Some would-be adopters will experience failure in their early attempts to adopt the new technology and be deterred from further effort until others have demonstrated success. Others who acquire knowledge of the new technology may have no appropriate opportunity to apply it. Although in the end the innovation may be widely adopted, the delay in acceptance may mean that benefits to users are not fully realized as soon as they might be.

If innovation is important to improving transportation system performance, then accelerating the rate of innovation is a worthy goal for DOTs and others responsible for the system's development, operation, and maintenance. Robust sharing of knowledge about new technology—within and among organizations—encourages and nurtures innovators and early adopters, thereby yielding this acceleration (Desouza et al., 2009; Rivas and Gobeli, 2005). While knowledge sharing can occur through virtually any form of communication, *technology transfer* (T^2) can be a particularly effective mechanism for motivating and facilitating knowledge sharing and accelerating innovation.

This guide is intended to accelerate the rate of innovation within and among DOTs through guided T^2 . Innovators play a key role in guided T^2 by providing information and evidence to others and showing what is possible, but others have roles as well.

Defining T²

T² is widely studied, but a review of the extensive literature and discussions with practitioners makes clear that the term has been used in many ways. There is no single, generally accepted definition for T². As used in this guide, the term T² **refers to a way that ideas, knowledge, practices, products, processes, or techniques are shared between and within organizations. As a purposeful action, T² involves at least two parties, a source and a recipient, engaged in the sharing of knowledge about new practices, products, processes, or other elements of technology. T² may be initiated by the source, the recipient, mutually by both, or by a third party acting to facilitate the sharing.**

The result of T² is that a recipient has learned about the new technology and is ready, willing, and able to adopt it. Recipients may seek T² because, for example, they wish to solve a problem, to pursue an opportunity, or to improve their own performance. Sources (such as researchers, inventors, or on-the-job problem solvers) may be motivated by a desire to improve current practice, provide service, or gain economic advantages. Third-party facilitators may be similarly motivated by desire to serve or improve current practices.

T² can begin and end with the sharing of intellectual capital—having acquired knowledge, the recipient may decide against any further action. Usually, however, T² participants expect that the outcome will be implementation, an application of the technology to address a need or take advantage of an opportunity to transform current practices and improve performance of the organization, the transportation system, or both.

Organized efforts to encourage T² are called *guided* T². Figure 1-2 is a graphical representation comparing Rogers' adopter categories for innovation to guided T² diffusion. The comparison points out the potential impact of guided T². The literature, including the experiences of T² practitioners, shows the likelihood that guided T² can reduce the overall time needed to reach a deployment decision.

The chart on the left of Figure 1-2 combines Rogers' categories of adopters with the rate of market penetration or technology diffusion as reflected in the "S" curve. In the early stages of diffusion, adoption is only being done by innovators and early adopters. Market penetration is relatively low and diffusion occurs at a slow pace. Diffusion accelerates and the S curve steepens as the early majority picks up the pace of adoption and the late majority comes on board. Last

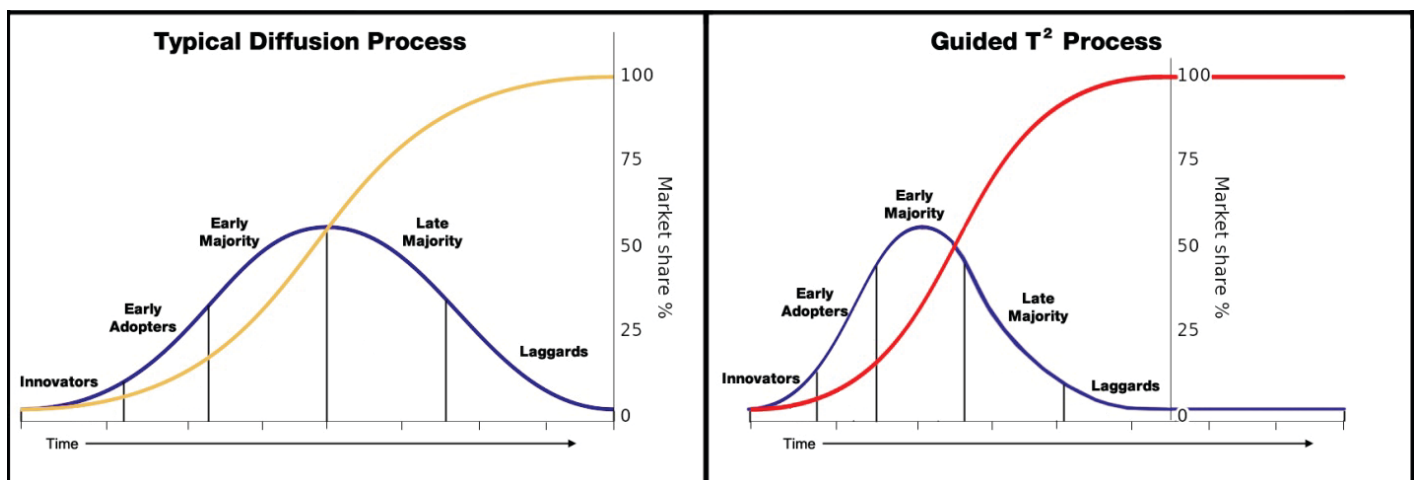


Figure 1-2. Conceptual representation of the intent of guided T².

to adopt are the laggards; fewer in number than the two groups that preceded them, the pace of adoption decelerates as diffusion approaches 100%.

Guided T^2 may be visualized as shifting the curve to the left, reducing the time required for a new idea to saturate its market. Through guided T^2 , early adopters and early majority users are encouraged to “take the leap” sooner. The proof of guided T^2 lies in the acceleration of benefits realized by the users or recipients of the new ideas.

The Innovation Adoption Process and Guided T^2

Guided T^2 is embedded in the process that advances innovation and brings new ideas to transportation organizations. This guide refers to the overall process as the “Innovation Adoption Process.” The Innovation Adoption Process has four broad phases—need identification, research and development, guided T^2 , and deployment. Chapters 2 through 11 will focus on guided T^2 , but it is also useful to understand guided T^2 in the context of the overall Innovation Adoption Process. A graphical representation of this process is shown in Figure 1-3.

The Innovation Adoption Process begins when an organization defines a need or identifies a problem and then searches for a technology that offers a potential solution. Sometimes research and development activity or an invention can motivate recognition of the need or problem. Potential solutions to problems, such as products that fulfill specific needs or new methods that improve current practices, are referred to in this guide collectively as *technologies*. Once one or more technologies have been identified for potential transfer, the organization determines the feasibility of the technology for its intended use. Guided T^2 , as defined herein, formally starts when an identified, feasible technology is available and work begins on transferring it into the organization. The Innovation Adoption Process culminates in a decision to deploy the technology or not to deploy it.

This section expands on each of the four phases shown in Figure 1-3, defines relevant terminology, and provides an example of the Innovation Adoption Process.

The Need

The Innovation Adoption Process begins with a **need**, a problem that requires a solution, something that would enable a transportation organization to improve its efficiency, effectiveness, or service to the traveling public. This is shown in the block at the top of Figure 1-3.

To respond to that need, the transportation agency may search for an existing solution, one that might be adapted to its situation. That search might begin with a simple query within the organization, which may lead to a wider, more global search for ideas outside of the organization. If a solution cannot be found internally or externally, it may be found through original research performed or commissioned by the organization.

Keep in mind that solutions or *technologies* in this guide can take many forms, including new or improved knowledge, tools, processes, or practices. Solutions/technologies may be something physical (e.g., a new type of plow blade or a new protocol for communication interfaces in vehicles equipped with intelligent transportation system technologies such as vehicle-to-vehicle or vehicle-to-infrastructure communications) or something intangible, such as improved knowledge about existing practice.

One of the challenges of some T^2 efforts is dealing with a “solution trying to find a problem.” Lack of a clear understanding of the need that is being addressed by a technology will hinder T^2 efforts. Likewise, simply showing that there is a problem that needs a solution may not be enough for effective T^2 . It is also important to identify the scope of a problem, how often it is

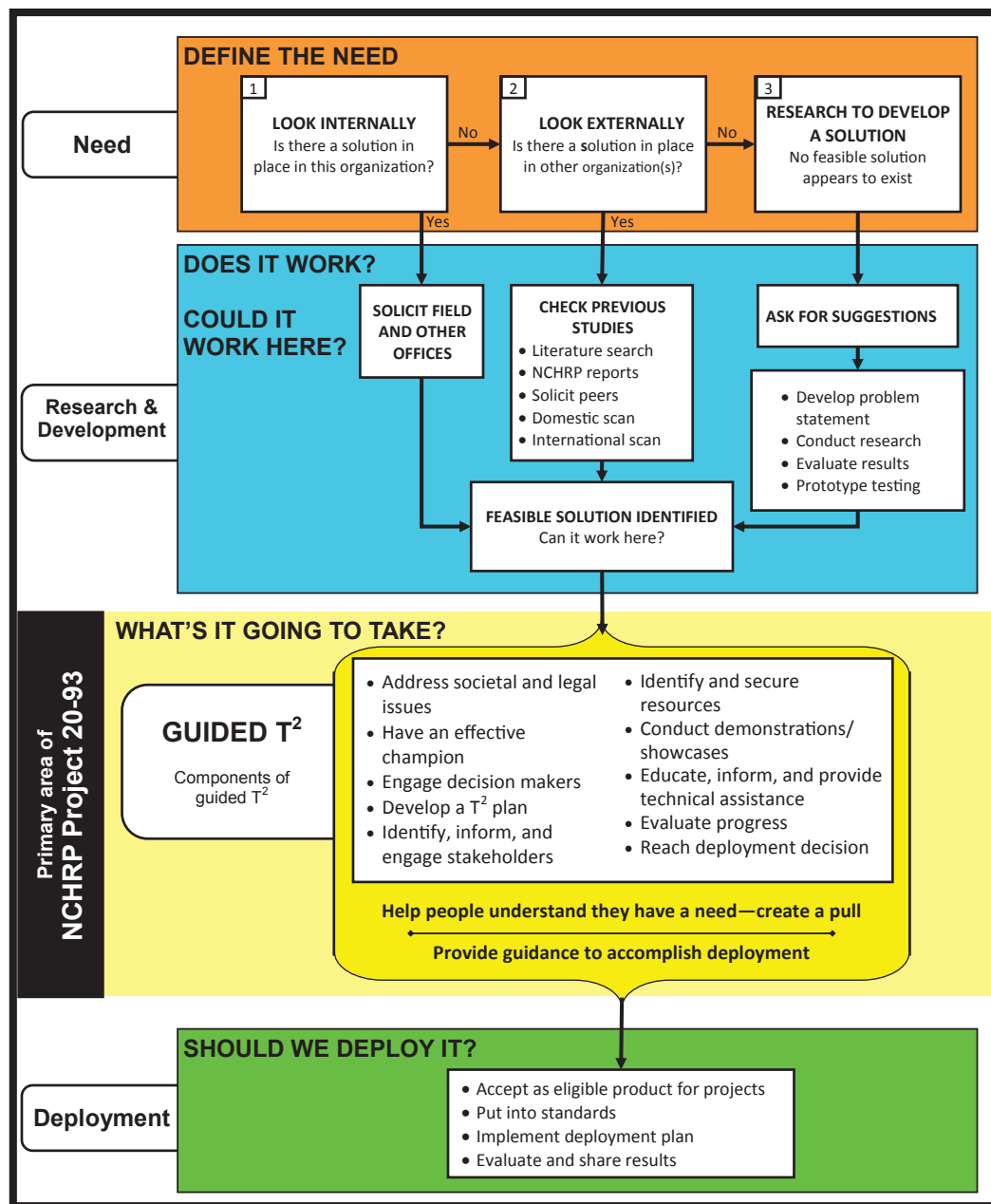


Figure 1-3. Innovation Adoption Process.

encountered, and the stakeholders for the problem and the solution. Even technologies that are developed to improve an existing practice or program must demonstrate that they do, in fact, result in a solution to a need.

On the other hand, another challenge of T² is that the potential end users of a technology being transferred may not always know that they have a need. As an example, in promoting technologies that could reduce run-off-the-road crashes, local officials often must first see the data that highlight the extent of the problem on their roads. After understanding the need, they may be far more open to investigating and adopting solutions.

T² opportunities may occur during the need identification part of the Innovation Adoption Process. These opportunities are described later in this chapter.

Research and Development

The **research and development** phase of the Innovation Adoption Process is shown in the second block of Figure 1-3.

This phase may take different paths depending upon whether an organization finds the technology internally or externally or whether the organization develops a research project with the goal of creating a solution. The process of discovery does not guarantee a solution will be found, but it enables the organization to take a step closer to understanding what may make a solution possible. Whether a search uncovers an existing technology or research leads to the development of a new technology, ultimately, the goal is to have a technology that addresses the original need and that is **feasible** to put into practice.

Feasibility connotes a number of characteristics: practicality, cost-effectiveness, efficiency, and durability, among others. This guide focuses on the feasibility of the solution before moving ahead into guided T² to ensure that time and resources are not wasted, and expectations are not falsely raised. As a test of feasibility, an essential question to ask is “If this technology were a viable solution for our need, could it be deployed here and now?” Feasibility may be difficult to determine conclusively because even with considerable evaluation and analysis, in the end, it is still a subjective decision. However, the following are some of the points that should be considered in making this determination:

- Has the technology been used successfully in similar applications?
- Can the technology be purchased or acquired now?
- Is the cost within a range that potential users may be able to afford?
- Is there compelling evidence for the benefits of this technology?
- Are there any legal or administrative barriers that could prevent application? (See Chapter 2.)
Does the need still exist?

Although a research effort may lead to a significant discovery that could change some aspect of transportation, only when a research result is incorporated into something that could be ready for deployment, is it considered a *feasible* technology in this guide. Therefore, a prototype that is still being tested and refined may not meet this definition.

While there are T² opportunities that can occur during the research and development phase of the Innovation Adoption Process (as described later in this chapter), at the end of the research and development phase, only the need has been defined and a feasible technology identified. Widespread deployment is not ensured; technology transfer must occur. The feasible technology is positioned for guided T².

Guided T²

The **guided T²** phase of the Innovation Adoption Process can begin once a specific technology has been identified as a feasible response to a need. This phase is shown in the third block of Figure 1-3. Guided T² is composed of 10 components:

- Address societal and legal issues
- Have an effective champion
- Engage decision makers
- Develop a T² plan
- Identify, inform, and engage stakeholders
- Identify and secure resources
- Conduct demonstrations/showcases
- Educate, inform, and provide technical assistance



Figure 1-4. Ten components of guided T^2 .

- Evaluate progress
- Reach deployment decision

Together, these components provide practitioners with a “roadmap” for undertaking guided T^2 , highlighting areas where challenges might be encountered and suggesting how those challenges might be overcome. These components are shown in Figure 1-4 and are described in detail in Chapters 2 through 11 of this guide.

Following a systematic approach to T^2 , that is, guided T^2 , can position a technology for successful deployment.

Deployment

Guided T^2 prepares potential adopters for application of the new technology. The **deployment** phase which then follows is shown in the fourth block of Figure 1-3.

Example of the Innovation Adoption Process—the Pennsylvania DOT’s Adoption of the Tow Plow

The name says it—a tow plow is a snow plow towed by a plow truck. When combined with a standard “V,” or swivel blade front plow, this device increases plowing width to 25 feet, or two full lane widths. When activated, the wheels of the tow plow turn up to 30 degrees to the right, causing the tow plow to steer out to the right of the plow truck. According to one county maintenance manager, “The tow plow allows the operator to clear two lanes simultaneously, reducing route time by half. This enhances productivity and saves fuel.” He added it can be equipped with tanks and/or hoppers to spread liquid, granular, or a mix of material, and also can be used as a pre-treatment trailer. When not in use, the tow plow simply pulls directly behind the plow truck as a normal trailer would.

The Pennsylvania DOT (PennDOT) adopted the tow plow on a trial basis and began a systematic evaluation. The tow plow was piloted successfully on a major Interstate in 2009. Based on that initial positive experience, PennDOT acquired additional tow plows and has continued evaluating the technology in 10 counties in several regions of the state.

PennDOT used an approach for adopting and deploying tow plows that encompassed many of the elements of an effective Innovation Adoption Process. The **need** to efficiently enhance

levels of winter service for Interstates and traffic routes was recognized. **Research**, specifically an **external scan** for possible solutions, identified the tow plow as a promising technology. PennDOT managers, particularly the maintenance operations director and fleet manager, determined that the tow plow was a **feasible solution** and moved to acquire and pilot test a tow plow early in 2009. With the maintenance operations director serving as a **champion** for adoption of the technology and **engaging decision makers** early on, the **guided T²** phase of the Innovation Adoption Process was underway.

At PennDOT's annual maintenance managers meeting in 2009, the tow plow was a featured technology that was **demonstrated** and **showcased**. A tow plow **educational** information bulletin was prepared and disseminated to **stakeholders** (district and county maintenance managers and equipment operators). PennDOT implemented a tow-plow **training** program to educate operators, focusing on safety—both for the equipment operators and the motorist. Because snow plows in operation can be difficult for following motorists to see, particularly at night, and because a tow plow is an unfamiliar sight, PennDOT's press office issued tips to **educate** motorists. Because the tow plow enables one truck to do the work of two, equipment operators expressed concern that full deployment of this technology would eliminate jobs. PennDOT managers addressed this potential barrier to change by providing assurances that jobs were secure, emphasizing that the efficiencies of tow plows allow for increased levels of winter services.

PennDOT continues to **evaluate** the performance of tow plows and their role in the mix of its fleet of snowfighting equipment. An evaluation committee composed of seven maintenance professionals, one from the central office and six representing field operations, was formed. Their methodology has been thorough and methodical, including elements of formative evaluation as well as summative evaluation, using both qualitative and quantitative evidence. Based on what it has learned through this evaluation, PennDOT has reached several key conclusions about using tow plows for its snowfighting operations:

- To justify their costs, tow plows should be deployed in regions that get the most snow events;
- Tow plows should be deployed on rural divided highways because these roads are suitable in terms of roadway characteristics (number of travel lanes and traffic volume), and travel distances to stockpiles are minimized (based on the locations of PennDOT's stockpiles);
- To maximize efficiency, tow plows should be equipped with hoppers for spreading both dry materials (e.g., salt and anti-skid) and liquids (e.g., salt brine).

PennDOT also learned the following:

- A truck mounted with a front plow and dual wing plows has about the same plowing width as a truck with a front plow pulling a tow plow, so if a fleet of trucks is already equipped with dual wing plows, tow plows may provide little or no added benefit; and
- A tow plow potentially takes the place of a truck and operator, but only reduces costs if the fleet is reduced by one truck and operator.

PennDOT's approach to innovation has been methodical, progressing over about 5 years as of this writing, and its plans for future deployment of the tow plow have, of course, been influenced by its guided T² evaluation.

Laying the Foundation for Guided T²

There may be actions that can be taken early in the Innovation Adoption Process that can lay the foundation for a successful guided T² initiative. Guided T² can begin even as a need is being identified or a technology is being developed or explored through research. For example, an

innovation champion may be identified while defining a need; decision makers may be engaged very early on to ensure the feasibility of the technology. In fact, during the need identification and research and development phases of technology development, knowledge sharing can build a foundation for subsequent T² activities, as well as provide an opportunity to explore key issues that could potentially present barriers to deployment.

There are many resources available that provide ideas and techniques for managing effective need identification and research and development programs. Although this guide does not seek to summarize or supplant those references, it does suggest how T² can be integrated into those activities. Further, practitioners may not have the opportunity to affect the development of research products; they may be charged with transferring those products after they have been developed. Therefore, a practitioner may be starting a T² effort from the most basic level. For this reason, this guide does not suggest that opportunities to guide T² during the need identification phase are a prerequisite for a successful guided T² effort. Instead, these opportunities can provide important building blocks that make the future transfer and deployment of the technology more successful and efficient.

While this guide focuses on the work to be accomplished in the guided T² phase of the Innovation Adoption Process, there are actions that can be taken in the need identification phase and research and development phase to lay a strong foundation for subsequent efforts to guide T².

Opportunities for Guided T² During Need Definition

There are multiple paths through which an individual or organization can begin a search for new ideas. However, they all have one thing in common—they are based on a **need**. Need identification initiates the Innovation Adoption Process. It is the starting point that defines why T² efforts should be undertaken, and it is the compass by which to chart a course to success. As such, the more clearly that the need is defined, the easier it will be to plan T² activities and focus on what the solution should encompass.

The need may be expressed as a problem to be solved or as a desire to improve an existing technology or process. It may be a national problem or a problem that only one county is facing. The need may also arise as the result of a policy, law, or regulation that mandates change. Regardless of its path, need identification begins with some form of need statement that should remain the cornerstone of all subsequent efforts, including T². Note that the need may be refined as the Innovation Adoption Process unfolds. The research and development phase may provide additional information that could modify or clarify the original need statement.

There are generally three broad paths that can be taken, often sequentially, to look for technologies to address a need, as illustrated in Figure 1-5. (Remember that potential solutions to problems, whether they are products that fulfill specific needs or new methods that improve current practices, are referred to collectively as *technologies* in this guide.) The three paths to

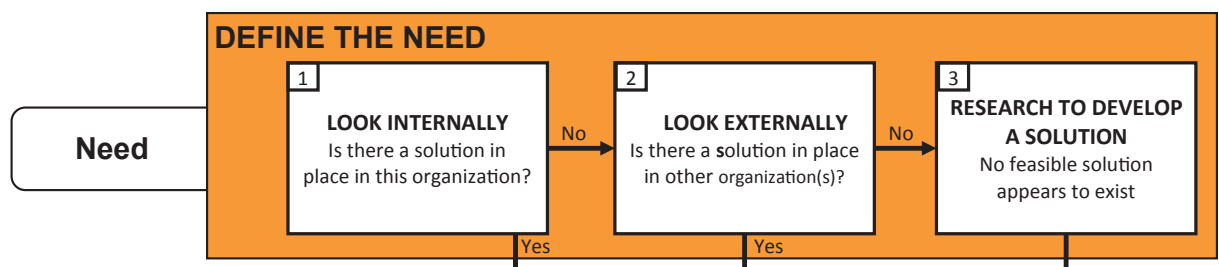


Figure 1-5. Defining the need in the Innovation Adoption Process.

searching for a solution are looking within the organization, looking outside of the organization, and initiating a research study to develop a solution.

Look Within the Organization for a Solution

It is possible that another individual within the organization of a practitioner searching for a solution to a problem has already faced the same problem, or a similar one, and has developed or found a solution. The technology may be a new process or approach or even a commercially available product that has been used with success. If the organization has a robust knowledge management system that encourages staff to regularly share ideas and experiences, the practitioner searching for a solution may be able to use the knowledge management system to find a technology that fits the defined need. If a knowledge management system exists and the search for a technology is unsuccessful, the system may still provide ideas on where to search next.

The implications for guided T^2 of taking this path are the following:

- If a technology to address a current need is available in an organization, gathering sufficient evidence to document that it has been successfully applied will be helpful in T^2 planning.
- Documenting the successful application of a technology in an organization can help persuade stakeholders and decision makers to consider it as a potential solution to the identified need.

Look Outside the Organization for a Solution

With millions of people working in the transportation sector, it is possible that the technology to satisfy the identified need already exists. Research reports, articles, professional journals, and product specifications are all places to look for potential solutions. The Internet, with its powerful search engines and global access, has greatly facilitated this process. However, Internet searches can be daunting, and sometimes they can fail to produce comprehensive reference searches that enable an adequate review of the literature. This is why the services of librarians and researchers that are trained in such investigations are particularly valuable. Other ways to look outside an organization include contacting peers and professional colleagues or soliciting input directly from other organizations that may have similar needs. Another approach is a “scan” of other states or countries to find potential technologies that address the need and then perhaps visiting those locations to investigate their implementation. All of these approaches basically involve looking for technologies that may already exist. However, even after an extensive exploration, it may be apparent that nothing currently fulfills the specific identified need, and a technology must be found or developed through original research.

The implications for guided T^2 of taking this path are the following:

- If a technology to address the identified need is available elsewhere, gathering sufficient evidence to document that it has been successfully applied will be helpful in T^2 planning.
- If a technology to address the identified need is available elsewhere, it may need to be adapted in the research and development phase to be made feasible for the agency before full effort can be applied to adoption of the technology.
- Documenting the successful application of a technology elsewhere can help persuade stakeholders and decision makers to consider it as a technology to address the identified need.

Initiate a Research Study to Develop a Solution

A research study provides a systematic approach to discovery. It often begins with the first two steps identified above: a practitioner looking for existing technologies both within and outside of his/her organization. In cases where a technology is found outside of the organization, it may require further development to match the needs and requirements of the organization. Many state DOTs have the capacity to either undertake research in their own facilities or manage contracted research conducted by universities, the private sector, or others. In virtually all

of these programs, there is a process for prioritizing, selecting, and funding a research agenda; a systematic approach to developing problem statements articulating the need for the research; and an evaluation process to select a winning proposal. This is an excellent pathway to T² and provides a rich opportunity to initiate T² activities early in the Innovation Adoption Process.

The implications for guided T² of taking this path are the following:

- The problem statement, which is used to initiate a research project, can be useful in subsequent T² efforts particularly if it provides information about the extent of the problem, its cost and frequency, and the target audience.
- Engaging stakeholders and decision makers in the identification of research needs can help ensure that problem statements reflect their priorities, as well.
- Most DOTs have an analytic ranking, review, and prioritizing process done before funds are allocated to specific research projects. In the end, all participants in the prioritization process will not only know about the research, but may also feel some ownership for it. Keeping this group informed and engaged as the technology is developed may help in identifying a champion and winning early supporters for implementation.

Opportunities for Guided T² During Research and Development

A technology that offers a potential solution to a defined need may be found through an internal search, an external search, or by conducting an original research study. In all cases, additional research and evaluation will be needed before the technology is ready to be transferred. This period of evaluation is not only an opportunity to determine whether a technology actually performs as intended, but is also an opportunity to evaluate the practicality and feasibility of the technology as a response to the identified need of a specific environment.

The research and development phase of the Innovation Adoption Process (see Figure 1-6) thus provides opportunities to begin laying the foundation for eventual T² activities and subsequent deployment and implementation activities. One way to lay this foundation is to communicate with stakeholders during the research and development phase; also important is developing leadership for a T² effort. Finally, the research and development phase offers an early opportunity to assess the feasibility of the proposed technology.

Communications

Using media to reach both internal and external stakeholders during the research and development process not only builds support for these efforts, but highlights technologies that may be

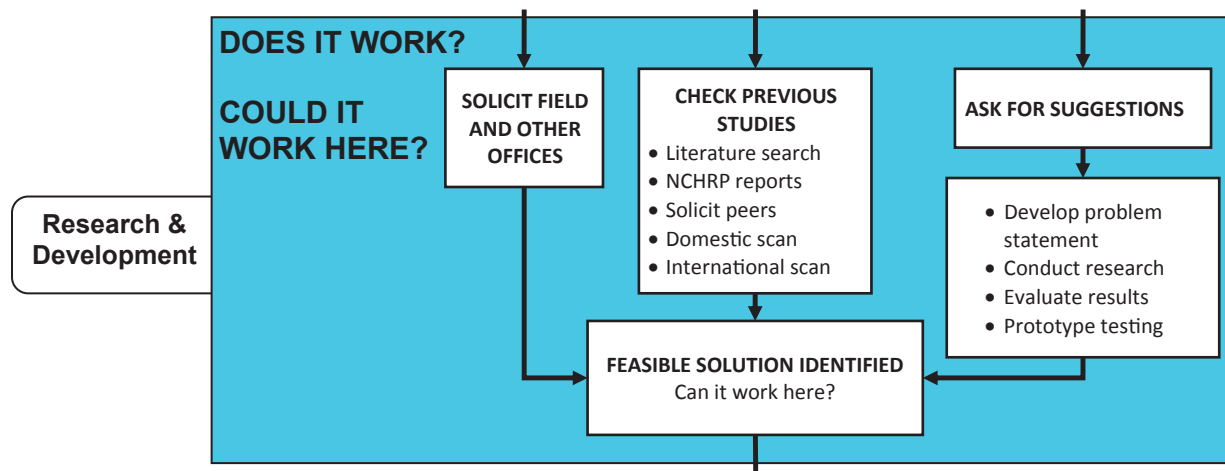


Figure 1-6. Research and development in the Innovation Adoption Process.

on the horizon. Although these technologies may not be ready to deploy for years, highlighting them early on can create a “pull” for them when they are ready to be delivered. It is important, however, to avoid building too strong an interest too early, before there is clearly a feasible technology; doing so may lead to disappointed and skeptical stakeholders.

Some communication strategies to help guide T² in the research and development phase are the following:

- Build interest in a research program through “Research Alerts” and other information exchanges that can serve as knowledge transfer mechanisms. Transferring information on current research projects can lay the foundation for more detailed, future T² efforts on completed research projects and newly developed technologies. (See Chapter 9.)
- Spotlight some of the researchers in an article in an organization newsletter or outside journal so that they can share information on some of the exciting projects they are working on. These newsletters can share knowledge on the latest innovations at a DOT and efforts to deploy them. (See Chapter 9.)
- For high-priority research products, provide management with regular updates on the progress being made. Not only does this deliver timely information and status, but it can also transfer knowledge related to the technology and how it might be useful to the DOT.

Leadership

One element of most successful guided T² efforts is having a champion to help bring attention, resources, and, ultimately, support to the technology. This component of guided T² is highlighted in Chapter 3. In addition to the champion, innovators and early adopters play a significant role in building the momentum for a deployment effort. Finally, the support of organization leaders in allocating the resources needed to make T² happen is critical.

Some strategies for building leadership for a guided T² effort are the following:

- Many organizations have research advisory groups that help set the roadmap for future research. These “Research Advisory Committees” or “Technology Steering Groups” can include not only internal stakeholders, but also external partners and stakeholders. These groups provide a great opportunity to identify people who may use the technology to solve a problem and may be willing to serve as a T² champion.
- Award programs can be established to recognize champions in an organization. The nomination process itself can help identify potential supporters and stakeholders and express the importance of these attributes to management.
- A champion may be found within the program office of the DOT that will be the biggest customer of the technology. In many cases, this may be the office or official that first promoted the research study or defined the need. Keep them engaged in the research and development process by reviewing progress and helping them stay focused.
- If the technology is likely to require some commercialization by a manufacturer, software producer, or other private sector interest, consider involving such a company in the research and development process so that they will have a greater desire to bring the technology to market.

Initial Assessment of Feasibility

As mentioned earlier, the research and development phase is not only an opportunity to determine whether the technology or research product actually performs as intended, it is also an opportunity to evaluate its practicality and feasibility. This is especially true as transportation research has moved into advanced technology applications such as nanotechnology, telecommunications, robotics, and integrated systems. Implementation of research in these areas presents many unique challenges and potential barriers. It is important to consider these challenges during the research phase before a substantial investment is made in technology transfer and deployment.

Other potential challenges include system integration and compatibility; privacy; patents, licensing, copyrights, and intellectual property rights; economic considerations; standards; and demonstrations and field testing.

System Integration and Compatibility. One persistent issue is how to introduce and integrate a new application into an existing system. This is particularly important in traffic management and control systems where there is a need to ensure that new hardware, software, and programs are compatible with the other existing elements of those systems. This is made even more complicated by the fact that many of these systems cross and serve multiple jurisdictions and must be compatible with each other. Ultimately, implementing such research products may require further development of the new product or modifications to the existing systems.

Although this issue arises in many electronically based systems, it can also arise in introducing innovations that would require modifications to existing maintenance or construction equipment, business protocol, or materials. Again, this simply highlights the importance of thinking through such issues while the product is being developed and tested.

Privacy. As new information-sharing technologies emerge, managing information considered private in some contexts has surfaced as an important issue. Individual privacy is a legal issue, and new technologies tend to push the boundaries of legal interpretation. As such, when introducing a new technology, researchers must consider what potential privacy issues may surface during implementation, even if the researchers themselves do not agree with public perceptions or potential legal interpretations. If necessary, changes may need to be made in the technology (e.g., its ability to identify and store information about certain drivers or their vehicles) to accommodate predominant perceptions.

Patents, Licensing, Copyrights, and Intellectual Property Rights. Issues relating to intellectual property may impact research products even before they advance to evaluation and testing and well before T² efforts. Many state DOT research programs are actually carried out by contracts or agreements with universities or other parties. Universities or other parties may claim ownership of any and all intellectual property rights that result from research done in their lab, on their campuses, or by their researchers. These claims can present a challenge for the “client” (e.g., the state DOT), which has likely paid for that research with public funds. It is therefore important that research managers look carefully at the conditions they set forth in doing contract research, particularly as it relates to the eventual deployment of a technology.

Economic Considerations. Early in the development phase, it may become apparent that the product may be too expensive to continue into T² and deployment efforts. This determination may be based on the cost of the product itself, or it may include an assessment of the costs projected to effectively deploy the technology (e.g., cost to develop and deliver specific training, retooling of existing systems, and maintenance and operation costs). If this is the case, researchers may want to consider developing a more cost-effective version of their work or wait until the expense of manufacturing and delivering the product decreases (as has been the case with many computer components).

Standards. Some research products require the adoption of new standards. In these cases, it is important to consider not only the process that may be needed to incorporate these products or processes into existing standards but also what further work may be needed to actually translate the products/processes into practical applications and protocols.

Demonstrations and Field Testing. Many research products require some field testing or development of a prototype. Testing and evaluation is an excellent time to gather data that will

be important in describing the benefits of a product and determining the attributes that would be of most interest to the target audience. Field tests can also be a very effective first step in a guided T² initiative. Such field tests provide an opportunity to invite prospective users to view the tests. However, the researcher needs to carefully consider whether the product is ready for public scrutiny or whether it would be wiser to conduct field tests in a more controlled environment. As noted in subsequent chapters, hands-on demonstrations of new technologies can be powerful elements of a T² program. Nonetheless, there needs to be strong confidence that the technology will, in fact, perform as it is intended to.

Using This Guide

Chapters 2 through 11 of this guide are focused on the guided T² phase of the Innovation Adoption Process. Each chapter details one of 10 components of guided T²:

- Address societal and legal issues
- Have an effective champion
- Engage decision makers
- Develop a T² plan
- Identify, inform, and engage stakeholders
- Identify and secure resources
- Conduct demonstrations/showcases
- Educate, inform, and provide technical assistance
- Evaluate progress
- Reach deployment decision

The 10 components encompass the variety of actions that form a systematic method of approaching T². Although a specific component may take priority or receive the greatest attention at times during the guided T² effort, in general, actions relating to many, and perhaps most, components will be ongoing throughout the guided T² process. Many components will be occurring at the same time. That said, there are some components that logically must be addressed earlier in the T² process and others later in the process. To provide practitioners with a general framework for when to address particular T² components, the research team has ordered the 10 components into three tiers:

1. **Foundational/Organizational Components.** These components establish the infrastructure for the guided T² process—foundational and organizational activities. Applicable components are the following:
 - Address societal and legal issues
 - Have an effective champion
 - Engage decision makers
 - Develop a T² plan
 - Identify, inform, and engage stakeholders
 - Identify and secure resources
2. **Knowledge-Building Components.** These components address knowledge building and understanding. They are used to inform stakeholders, decision makers, and end users about the innovation—why it is needed, its benefits, how it works, and so forth. These components can help the practitioner prepare training and marketing materials to promote decisions for transfer and deployment. These components may be used at several points in the guided T² process. Applicable components include the following:
 - Conduct demonstrations/showcases
 - Educate, inform, and provide technical assistance

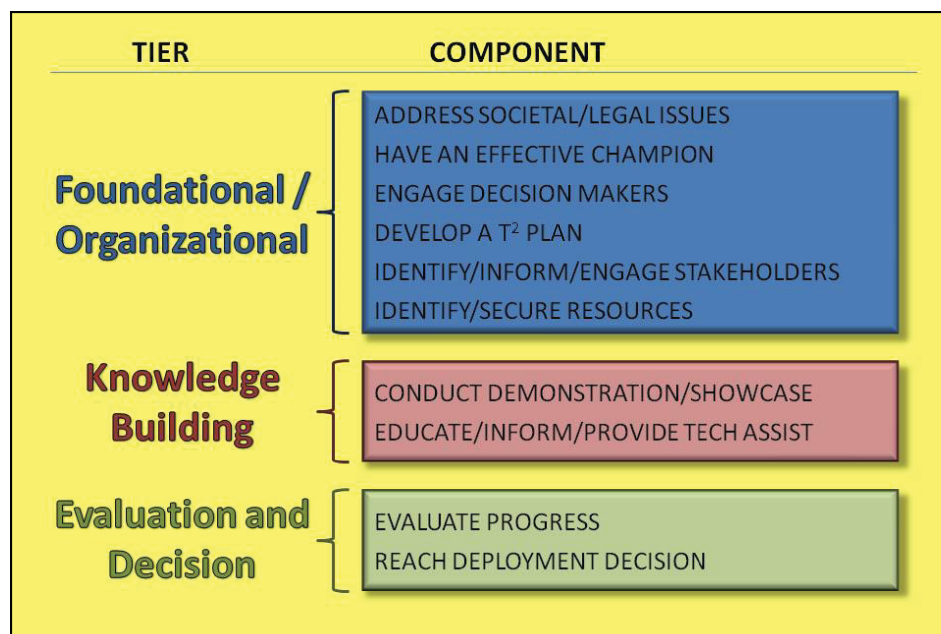


Figure 1-7. Guided T² component tiers.

3. **Evaluation and Decision-Making Components.** These components evaluate how T² efforts are proceeding and lead to the final decision regarding going forward to deployment. Applicable components include the following:

- Evaluate progress
- Reach deployment decision

In general, the foundational/organizational components should be addressed first, followed by knowledge-building components, and concluding with the evaluation and decision-making components. These three tiers and their activities are shown graphically in Figure 1-7.

Tier 1: Foundational/ Organizational Components

- Address Societal and Legal Issues
- Have an Effective Champion
- Engage Decision Makers
- Develop a T² Plan
- Identify, Inform, and Engage Stakeholders
- Identify and Secure Resources

Figure 1-8. Example graphic indicating component under discussion and tier level.

In Chapters 2 through 11, the components are presented in tier order, that is, foundational/organization components are addressed first, knowledge-building components are addressed next, and, finally, evaluation and decision-making components are addressed. Each chapter includes a basic description of the guided T² component accompanied by actions to consider, challenges and barriers often encountered, and tools and strategies to enhance the effectiveness of T². Some chapters also provide a list of suggested readings.

A graphic at the opening of each chapter shows the component under discussion, the tier to which the component belongs, and all the components in that tier (see Figure 1-8 for an example).

Also at the opening of each chapter are leading questions meant to help practitioners determine whether they need to review the component in detail (see Figure 1-9).

Users can approach Chapters 2 through 11 as a step-by-step guide to accomplishing guided T², as a tool to check whether all the necessary steps have been taken or effective practices incorporated, or as a means to determine solutions to a particular challenge. If experienced practitioners can identify the challenge they face as falling into one of the three tiers, they can go directly to that tier and its components.

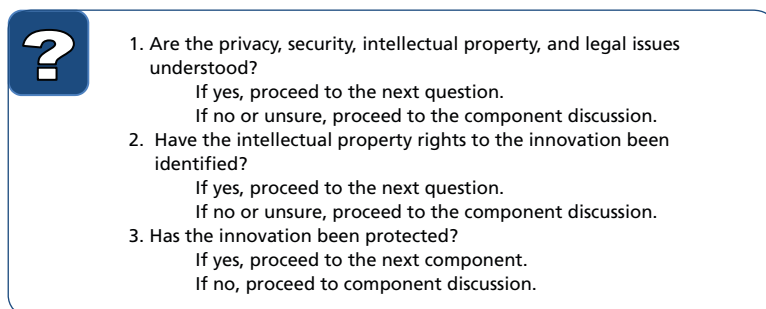


Figure 1-9. Example of leading questions.

All users of the guide should start by determining their T² experience level according to the following:

- **Novice.** This person is new to T² and is unfamiliar with the components of guided T². Novices start with little knowledge of T² other than they have a product that they want to move toward implementation and deployment. Novices may want to use this guide to
 - Transfer an innovative transportation technology, practice, or tool that they believe others will find useful or which they have been tasked with implementing
 - Ensure that T² is done well
 - Find effective practices
 Novice users will likely want to review all three tiers of guided T² components.
- **Experienced T² practitioner.** This person is familiar with guided T² and has worked with some or all T² components before. This person may be working on a T² initiative and want to check that he or she has done all that is necessary to ensure success. This person may know how to start a guided T² effort, but want to ensure that the application is thorough and complete. As with novices, experienced T² practitioners will probably want to use the guide to
 - Transfer an innovative transportation technology, practice, or tool that they believe others will find useful or which they have been tasked with implementing
 - Ensure that T² is done well
 - Find effective practices
 In addition, an experienced T² practitioner may just want a guided T² refresher. An experienced T² practitioner will probably not need to review all three tiers of guided T² components. Assessment questions at the beginning of Chapters 2 through 11 will help these users quickly focus on the component or components most helpful to them.
- **Experienced T² practitioner with a particular challenge to address.** This person is familiar with the guided T² process and is using the guide to address a particular T² issue or issues. This user will likely want to proceed to the components of most interest and value in meeting their needs, rather than reviewing all 10 components. Assessment questions will help these users quickly focus on the component or components most helpful to them.

Users can answer the following questions to determine their next step, based on their user experience level.

**Are you a T² novice?**

If **yes**, review all of the components in order:

1. Establish T² infrastructure by ensuring that all of the foundational/organizational components are addressed.
2. Review the knowledge-building components to enhance work done laying the foundation for T².
3. Review the evaluation and decision-making components that lead to possible deployment.

If **no**, choose another experience level.

**Are you an experienced T² practitioner who wants to check that you have done all that is necessary to ensure successful T²? Are you looking to apply effective practices?**

If **yes**, proceed to Chapter 2: Address Societal and Legal Issues.

At the start of the component is a series of high-level questions. If you answer yes to each of these questions, move to the next component. If you answer no to any of the questions, you are directed to review the component discussion.

**Are you an experienced T² practitioner with a particular challenge to address?**

If **yes**, turn to the chapter covering the component that most directly addresses the challenge or, if necessary, the tier most directly related to the challenge and review the components in the tier. If you are unsure of the tier or component to turn to, start at the beginning with the first tier, Foundational/Organizational Components, and the first component, Address Societal and Legal Issues.

Address Societal and Legal Issues



1. Are the privacy, security, intellectual property, and legal issues understood?
 - If yes, proceed to the next question.
 - If no or unsure, proceed to the component discussion.
2. Have the intellectual property rights to the innovation been identified?
 - If yes, proceed to the next question.
 - If no or unsure, proceed to the component discussion.
3. Has the innovation been protected?
 - If yes, proceed to the next component.
 - If no, proceed to component discussion.

Tier 1: Foundational/ Organizational Components

- *Address Societal and Legal Issues*
- Have an Effective Champion
- Engage Decision Makers
- Develop a T² Plan
- Identify, Inform, and Engage Stakeholders
- Identify and Secure Resources

Societal and legal issues present a broad array of T² challenges to transportation organizations. New technologies, particularly information-sharing technologies, tend to push the boundaries of legal interpretation with regard to individual privacy and corporate security issues. Intelligent transportation systems (ITS) applications, particularly those relying on monitoring transportation systems, should maintain a level of user privacy when involved in a guided T² effort, as described below.

Legal issues also include intellectual property topics such as industrial property, licensing, copyright, and patents. Another legal challenge may be “Buy America” regulations.

Privacy and Security

Privacy is a subjective concept—there is no scale or objective measure for privacy. It is a complex issue that can emerge in many contexts, some of which extend beyond the transportation industry (Bolan et al., 2008). For example, tolerance of invasion of privacy can vary based on culture. One study on designing safe and secure transit systems found that transit users in Great Britain are more accepting of invasions of their privacy as long as it is for security purposes, but transit users in Spain are much more resistant to the same privacy invasions (Taylor et al., 2005). Since many ITS applications monitor, identify, and track people as well as personal and commercial vehicles, they have the potential to violate the general public’s expectation of privacy (Fries et al., 2012).

In their work, Fries et al. outline current and changing privacy preservation practices within state DOTs (2012). Their survey and research focused on determining how state DOTs are

Privacy Concerns with California Smart Phone Application

Privacy concerns became a significant issue while Caltrans was evaluating and testing a smart-phone-based transit application. In order to solicit volunteers, the project was advertised through several media avenues and a free iPhone was offered to those users-travelers who would be willing to participate in the field test. During the initial stage of the project, large numbers of users opted out of the preliminary testing phase because of **concerns for their individual privacy**. They believed the system lacked adequate safeguards to protect their privacy, particularly information that could be used to track their movements. These concerns were a setback for the research project and delayed implementation (M. Y. AlKadri, personal communication, May 10, 2013). This illustrates the importance of addressing privacy concerns before moving toward full-scale deployment.

meeting the privacy needs of the traveling public. The Fries et al. paper (2012) indicated that while privacy will continue to be a significant barrier to potential vehicle mile tolling and connected vehicle infrastructure technologies, DOTs currently favor

- Aggregating and masking data for protecting privacy of motorists while collecting travel times and speeds using ITS applications such as tracking cell phones, toll tags, and so forth.
- Abiding by legislation or agency policies when capturing video surveillance—broadcasting traffic cameras over the Internet, red-light-running enforcement, license plate data, and so forth.

Unfortunately, there is no national legislation in the United States for the privacy protection of travelers related to ITS activities (Bolan et al., 2008). Limited guidance can be found in the Intelligent Transportation Systems American (ITSA) Fair Information and Privacy Principles (ITS America, n.d.) and the VII (Connected Vehicle) Privacy Policies Framework (The Institutional Issues Subcommittee of the National Vehicle Infrastructure Integration Coalition, 2007).

Privacy and security issues can be clearly present and known to be a factor in T² as early in project activities as when an agency finds an existing solution to a need or in the research and development phase. Addressing privacy/security issues may be appropriate *before* an innovation is ripe for advancing through the guided T² stage, as defined in this guide. These issues should be considered in the research and development phase of the Innovation Adoption Process, before more specific T² activities ensue.

Intellectual Property

The World Intellectual Property Organization (WIPO) broadly associates intellectual property with creations of the human mind (WIPO, n.d.). While the organization does not define intellectual property, it does list the subject matter, or intellectual property, that is protected by *intellectual property rights*. Zhang et al. (2012) divide WIPO's list into two main categories: industrial property and copyright. Industrial property includes inventions, industrial designs, and trademarks. Copyright includes literary and artistic works, as well as digital intellectual property.

Of the two main categories, industrial property has traditionally been of primary interest to the transportation industry. WIPO defines an invention as a new solution to a technical problem, with an emphasis on *new*. New solutions are ideas and must be protected as such. A patent is a

right granted to an inventor by a state that “allows the inventor to exclude anyone else from commercially exploiting his invention for a limited period” (WIPO). Note that the patentee is not given a statutory right to exploit his own invention. A patentee is in a position to exclude others from using the invention or to allow others to use the invention by granting a license.

Protection under patent law does not require that the invention be a physical object. WIPO distinguishes between product inventions and process inventions; product inventions may be protected by product patents, and process inventions may be protected by process patents.

While WIPO uses the term “invention” to represent one category of industrial property, this guide may be better served with synonymous terminology. Schon (1967) uses the term *technology* to describe, “any tool or technique, any product or process, any physical equipment or method of doing or making, by which human capability is extended.” This definition is similar to the WIPO definition of invention in that it asserts that an invention

- Is a product of human creation
- Is new, in that it extends human capability
- Is an object *or* process

While industrial property issues have traditionally been of primary interest to state transportation agencies, digital technology has emerged as an integral part of transportation agency processes and procedures. The protection of digital intellectual property is afforded by copyright law. As such, plans and drawings are copyrightable as “pictorial, graphic, [or] sculptural works” (Eales v. Environmental Lifestyles, Inc., as cited in Thomas, 2013). Original digital models and audio-visual works are also protected by copyright. In the United States, copyright protection is granted by the Constitution, whereby Congress is empowered to grant “Authors and Inventors the exclusive right to their respective Writings and Discoveries.” Under the laws of many states, state agencies have the right to copyright works produced by their employees.

There are two main reasons for establishing laws to protect intellectual property. The first is to protect the rights of both the inventor and the public. The inventor has moral and economic rights inherent to the act of creation, and the public has a right to access that invention. According to WIPO, “In return for the exclusive right, the inventor must adequately disclose the patented invention to the public, so that others can gain the new knowledge and can further develop the technology.”

The second reason for establishing laws protecting intellectual property is to encourage fair trade, contributing to social and economic development (WIPO). These reasons for protecting intellectual property apply to patents for industrial property as well as copyrights to protect literary, artistic, and digital intellectual property (Thomas, 2013).

State DOTs should recognize that, unless prohibited by state law, they may seek intellectual property protection for new innovations or digital works developed by their staff. However, if an innovation is developed by an independent contractor, the innovation belongs to the contractor unless an agreement is in place that designates the work as “for hire” (Thomas, 2013). When developing contracts with researchers and others, DOTs should work with their legal counsel to include language specifying the intellectual property rights of any products resulting from the particular project. Language should be state specific and should note that the ownership of intellectual property generated during the course of a contract may be retained by the contractor or DOT by specifying ultimate ownership in the contract instrument. NCHRP Project 20-89, Intellectual Property Management Guide for State Departments of Transportation, focuses on intellectual property rights activities for state DOTs. It provides practical assistance to decision makers for determining strategies and business practices.

Recognizing and managing intellectual property rights pervades the entire Innovation Adoption Process, from defining a need, through searching for a solution, to deploying a solution.

From the moment a solution to a need is identified, an innovator must be concerned with the ownership of that solution. If an identified solution already exists, its effective use depends to a great extent upon its legal availability. If a potential solution does not exist and must be invented, then the possibility exists for securing the rights to that new knowledge, product, or process.

Any work done during the research and development phase of Innovation Adoption Process must include an awareness of the ownership rights of innovations found through literature searches, scans, and other surveys of extant knowledge. If an applicable solution is found, and rights to the innovation belong to others, licensing might be a possibility and discovering that possibility should be part of the research. If new knowledge is developed (intellectual property), an innovator's research must also include the affirmation of "newness" and engaging intellectual property rights professionals to secure those rights if desired.

As previously mentioned, many state DOT research programs are actually carried out by contracts or agreements with universities or other parties. Contractors may claim ownership of any and all intellectual property that results from research done in their labs, on their campuses, or by their researchers. This ownership right can present a challenge for a DOT, which has likely paid for that research with public funds. Because these situations exist, research managers need to look carefully at the conditions they set forth in accomplishing contract research, particularly as it relates to the eventual deployment of a technology.

While *knowledge gathering* about intellectual property issues associated with an innovation will likely occur during the research and development phase of the Innovation Adoption Process, the real *management* of intellectual property will take place during the guided T² phase. By the time an innovator reaches the guided T² stage of the Innovation Adoption Process, it should be known whether licensing an innovation is appropriate or establishing intellectual property rights for new knowledge is a possibility. The appropriate T² actions can then be taken.

Virginia DOT Creates Intellectual Property Handbook to Help Employees Address Intellectual Property Issues

The Virginia Department of Transportation (VDOT) has created a handbook that provides guidance to its employees about **intellectual property**. The handbook indicates that "Because intellectual property is a dynamic field of law, this handbook is neither a comprehensive guide nor an accurate predictor of legal developments. This handbook is merely an effort by the Virginia Transportation Research Council to provide VDOT employees guidance in addressing the intellectual property issues they may face during the scope of their employment." The handbook provides specific guidance to VDOT employees early in the development process if their invention or creation has any commercial value or may be of any interest to the Commonwealth. It also emphasizes that anything that is developed by an employee of the Commonwealth during working hours (working within the scope of his or her employment or using state-owned or state-controlled facilities) that could qualify for a patent or copyright is the property of the Commonwealth. This handbook serves an important role, especially considering VDOT's commitment to innovation and the growing importance of intelligent transportation systems (ITS). VDOT has taken the position that a key factor in the implementation of ITS is the appropriate management and use of intellectual property (Virginia Transportation Research Council, 2006). The handbook can be accessed at http://www.virginiadot.org/vtrc/main/online_reports/pdf/07-r3.pdf.

Intellectual Property Considerations

What Actions Should Be Considered?

Assess an available innovation

- Does the innovation exist in the public domain?
- Is there a current patent or copyright on the innovation or is a patent or copyright for the innovation being sought by others?
- If patented or considered for patent, can the innovation be licensed?
- Can the innovation be revised such that it no longer encroaches on existing patents or copyrights?
- Is the innovation being considered available in the United States or available only outside the United States?

Assess new knowledge

- Is the new innovation truly new?
- If new, should the innovation be patented or copyrighted?
- If patented, should the innovation be licensed to facilitate deployment:
 - Are potential licensees requesting use of the innovation?
 - Does the innovation need to be marketed to attract potential licensees?

Assess the organization's intellectual property rights resources

- Does the organization have the resources to pursue a patent or copyright?
- Should the organization hire counsel to pursue a patent or copyright?
- Was federal funding used in the development of the innovation?
- Was the innovation developed under the work-for-hire provision of the Copyright Act?

What Are Some of the Challenges to Managing Intellectual Property Rights Issues?

A management structure that is not conducive to pursuing intellectual property rights issues

- Lack of cultural propensity
- Lack of knowledge
- Lack of will

Dysfunctional relationships among disparate organizations engaged with an innovation, such as a state DOT implementing university research

- Disagreement about value of intellectual property
- Disagreement about the ownership of intellectual property
- The timing of publications in the intellectual property rights process

Slow-moving organizational approval processes

- Lack of a champion
- Overwhelming bureaucracy

Lack of product development experience, which is necessary for meeting patent registration requirements or effectively using a license

- On the part of the innovator
- On the part of the champion
- On the part of the organization

Need for funding to support intellectual property rights activities

- Hiring outside counsel
- Managing licenses
- Managing licensees
- Developing manufacturing capacity

What Are Some of the Tools or Strategies Available for Overcoming the Challenges to Managing Intellectual Property Rights Issues?

Gaining support from top and middle management

- Articulate the value of well-managed intellectual property rights
 - Patenting an innovation affords control over the use of the innovation by either limiting competition or selling licenses
 - Securing a patent limits the fear of theft when demonstrating an innovation to industry
 - Purchasing a license to use a patented innovation can reduce research and development and other development costs
- Push for intellectual property rights activities to be included in the organization's business plan

Effective partnering

- Consider partnerships carefully; effective partners have
 - Similar goals
 - Similar organizational values and ethics
 - Similar valuation of intellectual property
- Balance the intellectual property rights of all partner organizations

Organizational education about intellectual property rights issues

- Every member of an organization should recognize the value of innovation
- Define the roles of each level of responsibility within the organization with regard to intellectual property rights
- Encourage a sense of responsibility and respect for the legal issues of intellectual property rights

A sufficient budget for intellectual property rights activities

- Budgeting for intellectual property rights activities depends largely upon the expectations of the organization's management
 - Is innovation an occasional occurrence? Budget for outside counsel
 - Is the expectation of constant innovation part of the organization's business plan? Budget for internal intellectual property rights management structure
- Include intellectual property rights activities when developing long-range budgets

The use of outside patent counsel is vital for those organizations with little intellectual property rights experience

- Select counsel with familiarity with the Bayh-Dole Act if federal funds are used for developing an innovation

NCHRP Project 20-89, Intellectual Property Management Guide for State DOTs

- The focus of this project is intellectual property rights activities for state DOTs
- Guide will provide practical assistance to decision makers for determining strategies and business practices

Other Legal Issues: Buy American, Buy America

An issue that may need to be considered in a guided T² effort is the Buy American Act, and the later Buy America provisions. The Buy American Act of 1933 (Act) was intended to encourage domestic use of goods and materials manufactured in the United States. The Act applies to procurements larger than \$3,000 and requires that substantially all goods purchased with federal dollars be mined, produced, or manufactured in the United States. “Substantially all” is determined by regulation, which interprets the intent of the Act as asserting that not more than 50% of the cost of all components may be of foreign origin. There are exceptions to the Act. The Act does not apply if its application is inconsistent with the public interest or if domestic material is of unreasonable cost. Further, the Act does not apply to those procurements for use outside the United States or if the required material is not commercially produced in the United States in reasonably available quantities (Luckey, 2012).

The Act has been regularly amended, and these amendments have tended to focus on the interpretation of the definition of “substantially all” to require a lower percentage of foreign materials or goods or to better articulate restrictions and exceptions for trade agreements. There have been several other laws enacted to restrict procurements, and these, too, tend to focus on the domestic content requirements for *non-direct* purchases and *direct* purchases (Luckey, 2012).

An example of a law stipulating the domestic content of *direct* purchases is the Berry Amendment, which focuses on direct purchases made by the U.S. Department of Defense (DoD). This amendment requires that 100% of certain textiles and specialty metals procured by the DoD are of domestic origin (Luckey, 2012). These procurements are considered direct procurements because the federal government, in this case the DoD, is making the purchases.

Of more interest to the transportation industry is Buy America, which encourages the use of domestic materials procured through *non-direct* purchases, specifically the use of U.S. DOT funds that are passed on to non-federal public agencies for transportation projects. Buy America requires that all steel, iron, and manufactured products used in projects funded with FHWA dollars be of domestic origin unless:

1. Their application would be inconsistent with the public interest;
2. Iron, steel, and the relevant manufactured goods are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or
3. Inclusion of iron, steel, or manufactured goods produced in the United States will increase the cost of the overall project by more than 25%.

Buy America law is found in Title 23 *United States Code*, Section 313—Buy America (23 USC §313), and in regulation in the *Code of Federal Regulations* Title 23—Highways, Section 635.410 Buy America Requirements. Similar provisions can be found for U.S. DOT administrations such as the FAA, the FRA, the National Railroad Passenger Corporation (AMTRAK), and the FTA; however, only the provisions for the FHWA are referred to as Buy America (FHWA, 2013).

In 2009, the American Recovery and Reinvestment Act (ARRA) was enacted to include domestic content requirements called Buy American. The ARRA is an appropriation rider, which means it is a temporary law. Congress required that all ARRA funds be subject to the Buy American Act, including direct and non-direct procurements (Luckey, 2012). Specifically, the Buy American portions of ARRA (Section 1605) prohibit use of recovery funds for a project for the construction, alteration, maintenance, or repair of a *public building or public work unless all of the iron, steel, and manufactured goods* used in the project are produced in the United States. These provisions apply specifically to the use of ARRA funds and will become moot when all ARRA funds have been distributed and spent.

Addressing Legal and Regulatory Requirements for Effective T² in Iowa

In early 2010, Iowa DOT was asked by the TRB Strategic Highway Research Program 2 (SHRP2) to participate in a demonstration project involving accelerated bridge construction (ABC). The U.S. 6 bridge over Keg Creek in Pottawattamie County was completely replaced using innovative methods: prefabricated off-site using ultra-high performance concrete (UHPC) and preassembled rolled steel girder units, among others. These innovative methods are also repeatable at other locations with other bridge replacements. Iowa DOT partnered with FHWA, SHRP2, HNTB Corporation, and Iowa State University, along with industry representatives for the demonstration. The Iowa DOT closed the roadway for only 2 weeks for the bridge replacement, while traditional construction methods would have required the partial or complete closure of the road for several months, resulting in substantial traffic disruption. Benefits of these partnerships came to the forefront in overcoming a barrier faced just before the project was let: **Buy America requirements**. The fibers used in the UHPC were made exclusively in Europe, and Buy America provisions are relevant to the steel fiber reinforcement used in UHPC. Iowa DOT's FHWA partners locally and in Washington DC were critical in securing the necessary waiver for the Buy America requirements and allowed the project to move forward without delay. (Interview with Sandra Larson, Iowa DOT, on July 1, 2013)

More recently, the Moving Ahead for Progress in the 21st Century Act (MAP-21) amended 23 USC §313 to broaden the application of that law to any contract eligible for FHWA funding “carried out within the scope of the applicable funding, determination, or decision under the National Environmental Policy Act (NEPA), regardless of the funding source of such contract if at least one contract for the project is funded with federal-aid highway funds.” (Montague, 2013). A typical project described in a NEPA document might be funded by several sources, so this new amendment to Buy America expands the reach of Buy America provisions to work that is eligible for federal funding, even if federal funding is not used (Montague, 2013).

Important to practitioners who are guiding T² are the primary exceptions to Buy America noted above. Waivers to the provisions of Buy America are available if the head of the FHWA finds that

1. Their application would be inconsistent with the public interest;
2. Iron, steel, and the relevant manufactured goods are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or
3. Inclusion of iron, steel, or manufactured goods produced in the United States will increase the cost of the overall project by more than 25%.

If the technology considered for implementation, or parts thereof, is only manufactured outside of the United States, practitioners will need to work with FHWA to obtain necessary waivers to continue the advancement of an innovation through the guided T² phase.

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CHAPTER 3

Have an Effective Champion

Tier 1: Foundational/ Organizational Components

- Address Societal and Legal Issues
- *Have an Effective Champion*
- Engage Decision Makers
- Develop a T² Plan
- Identify, Inform, and Engage Stakeholders
- Identify and Secure Resources



1. Is there an effective champion?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
2. Does the named champion meet all needs/expectations?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
3. Would you like to review the champion's role?
If yes, proceed to component discussion.
If no, proceed to the next component.

An effective champion is a basic element of guided T². In fact, the influence of champions with a positive bias for change is well documented in several of Everett M. Rogers' works, including his classic text on technology innovation, *Diffusion of Innovations*, 5th edition (2003), and also in an article addressing specifics on T², "The Nature of Technology Transfer" (Rogers, 2002).

In *Diffusion of Innovations*, Rogers describes champions of innovation as "individuals in an organization who provide enthusiastic support for a particular new idea" (2003). He further characterizes champions as those "[who] may connect an innovation with an organizational problem and may identify the financial or personnel resources needed to adopt and implement the new idea. Champions act as cheerleaders for technological innovations, including their transfer from external sources" (Rogers, 2003). When Rogers is discussing champions in "The Nature of Technology Transfer," he states that, "A champion is defined as a charismatic individual who throws his or her support behind an innovation, thus overcoming the indifference or resistance that the new idea may provoke. Research has shown that innovation champions may be powerful individuals in an organization, or they may be lower-level individuals who possess the ability to coordinate the actions of others" (2002).

Rogers acknowledges that it is certainly not bad to have a highly placed, powerful individual within an organization to be a champion, but he also notes that those who are less senior are more accessible to others in the organization:

The important qualities of champions were that they (1) occupied a key linking position in their organization, (2) possessed analytical and intuitive skills in understanding various individuals' aspirations, and (3) demonstrated well-honed interpersonal and negotiating skills in working with other people in their organization. Thus champions were brokers and arrangers for an innovation in an organization, helping fit it into the organizational context. (Rogers, 2003)

Rogers's discussion on the role and characteristics of champions clearly describes an aspect of T² relevant to transportation practice.

Transportation practitioners also acknowledge the critical influence of champions for T² efforts. In *NCHRP Synthesis 355: Transportation Technology Transfer: Successes, Challenges, and Needs*, state DOT research units and Local Technical Assistance Program (LTAP)/Tribal Technical Assistance Program (TTAP) representatives identified the presence of a champion as a highly important strategy or factor affecting T²:

Champions were drawn from the practitioners, from management, and from within advisory committees. If champions had not been identified, respondents [to surveys administered for the synthesis] advised finding them and involving them directly in the project. Champions facilitate T² by perseverance—not giving up until the project succeeded, they foster user ownership, recognize future benefits, provide needed impetus for introduction to change, and create faster buy-in with management and workers. (Harder and Benke, 2005)

T² involves change—fostering the movement from the current and most likely familiar to something new, innovative, and potentially unfamiliar. Champions help span the gap that exists between the current-familiar to the new-unfamiliar.

Effective Champion: Geosynthetic Reinforced Soil in Defiance County, Ohio

Geosynthetic Reinforced Soil—Integrated Bridge System (GRS–IBS) is an Accelerated Bridge Construction (ABC) technique that focuses on the application of soil stabilization technology for bridge substructure construction. Used primarily for bridges on low-volume roads, GRS–IBS technology can reduce the costs of standard bridge construction by 25% to 30% (Adams et al., 2008). In 2005, Defiance County, Ohio, teamed with the FHWA to build a prototype GRS–IBS bridge in 6 weeks, rather than the conventional several months, and realized cost savings of 25%. Based upon the success of that prototype, the **County Engineer championed the technology** by recognizing its value and making a commitment to using it throughout the county. Working in collaboration with his FHWA partners and serving as a local champion, the County Engineer not only succeeded in building the prototype bridge for less money and in a shorter time, but he went on to realize more benefits for the county by building at least 18 more bridges with the GRS technology with local resources. Committing county resources (personnel and financial) to further the deployment of this technology demonstrated his commitment to champion the technology. He further championed the technology by co-authoring a paper (Adams, 2008) about the prototype bridge built with FHWA that included empirical evidence about the construction technique as well as the stability of the completed bridge so that others could benefit. FHWA's research geotechnical engineer provided both design and construction assistance to the initial bridge construction, strengthening the effect of the local champion, who tapped this nationally available expertise to further the work to be done in Ohio. In addition, the County Engineer recognized that **FHWA also serves a champion for the technology**, by providing webinars, training videos, design guides, and standard plans to help promote and disseminate the technology for Ohio as well as throughout the United States (U.S. DOT, 2011). <http://www.fhwa.dot.gov/publications/research/infrastructure/structures/11027/index.cfm>

<http://www.fhwa.dot.gov/publications/research/infrastructure/structures/11026/11026.pdf> (U.S. DOT, 2012)

Champions fulfill their role through their technical credibility, contagious enthusiasm, perseverance, and interpersonal skills. The presence of such advocacy for the T² activity is highly desirable, and significant effort should be made to ensure that such talent is available for each transfer task undertaken. Both the general literature and transportation experience suggest that without a champion, a T² effort is particularly difficult.

Champions can emerge from various sources associated with T² activity, for example, from upper management who extend organizational power to foster buy-in, supply resources, and ensure willing recipients of change. However, drawing attention to T² at that level does not routinely occur unless the activity is a highly visible, high-risk, or politically hot issue (Rogers, 2003). For the most part, T² champions for transportation applications are found in middle management or among operational and technical staff who are perceived as knowledgeable and credible by their peers and colleagues. Often these champions are located in the organization that will be using the outcome of the transfer, but they can be highly credible individuals who are strong advocates for change from outside the ultimate user organization, as well.

For a practitioner looking to enlist all the strategies possible to increase the likelihood of successful T², identifying a competent and effective champion to assist in facilitating the guided T² effort is essential. In many guided T² efforts, a champion self-identifies simply by being an informed innovator, the most vocal technically credible advocate for the transfer effort. These champions are convinced that the technology (knowledge, process, or technique) is beneficial and should be considered or used. In other guided T² efforts, careful review of technically competent people may be required to surface a champion.

Considerations Regarding a Champion

What Actions Should Be Considered?

Assess the availability of a champion

- Has a champion self-identified? Are the capabilities of this champion adequate?
- Does a champion need to be identified?
- Is there a champion at the executive level of the organization?
- Who is the credible, capable, and available champion from middle management or operational/technical staff?
- Does the champion have experience managing and negotiating interagency and regulatory issues (budget, environmental protection, legislative, etc.)?
- Has the champion worked with decision makers of other agencies to successfully resolve such issues previously?

Identify (name) and establish a champion for the guided T² effort

- Formally recognize the champion(s), whether self-identified or named through an organizational selection process
- Provide support as appropriate to facilitate the champion's activities

The goal of the assessment is to formally identify a champion for the guided T² activity. There may be significant challenges in identifying and establishing a champion, yet getting a capable champion is critical. Additionally, support of the champion, once formally identified, will enhance the champion's effectiveness. If no champion can be identified, revisiting the viability of the guided T² effort may be necessary.

What Are Some of the Challenges and Barriers to Identifying and Establishing a Credible, Capable, and Available Champion?

- Recognizing a champion
- Getting a qualified champion to emerge
- Accurately defining the champion's role
- Shortcomings associated with the champion
 - Lack of credibility with peers and others
 - Inadequate technical competence
 - Lack of focus on organizational objectives
 - Collateral duties that reduce availability
 - Overpowering or misdirected advocacy
 - Intolerance for administrative processes
- Reluctance for management to approve/endorse a champion
- Champion not located in the organization that will use the outcome of the guided T² effort
- Lack of resources hinders effectiveness of champion
- Turnover/loss of champion mid-effort
- Managing the executive-level champion

What Are Some of the Tools or Strategies to Overcome the Challenges Encountered?

Recognizing a champion

- List the characteristics of a champion and match them with potential people who may fill the role
- Describe the expectations of the champion's role and discuss the availability of a champion with management
- Scan for potential champions

Getting a qualified champion to emerge

- Identify and explain the need for an effective champion to potential champions
- Communicate role, responsibilities, and expectations as described above
- Work with the champion's management to remove barriers for the champion's engagement

Accurately defining the champion's role

- Describe responsibilities and expectations
- Identify unique conditions for the specific transfer effort that can affect the champion's role
- Work with the champion to better define the T² plan and the champion's role

Address shortcomings associated with the champion

- Improve credibility with peers and others
 - Determine where credibility can be strengthened, add others with well-accepted talents to assist the champion
 - Communicate the champion's competence
 - Strengthen the champion's image with peers
 - Engage management support to endorse the champion's credibility
- Improve technical competence
 - Provide technical training and education to strengthen the champion's understanding of the technology
 - Identify others with superior technical competence to partner with the champion as needed

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- Improve strategic skills and marketing and communication competence
 - Provide opportunities for training and mentoring to enhance interpersonal skills such as building influence, trust, and credibility; exercising creative solutions; and problem solving and other skills associated with marketing and communications such as public speaking and team building
- Focus on organizational objectives and T² goals
 - Create well-articulated statement of the T² goals and how they align with organizational objectives
 - Have regular meetings with the champion to ensure focus
 - Listen to the champion for indications of other productive avenues for T²
- Reduce collateral duties that reduce availability
 - Communicate a clear definition of the roles and responsibilities of the champion to his or her managers and review with them the earlier commitment given (accountability)
 - Identify support needs that can be provided by others to assist the champion
 - Provide tools to assist the champion in maximizing his or her sphere of influence
- Direct proper levels of advocacy
 - Provide open and honest communication with the champion regarding effectiveness
 - Limit or redefine the champion's role to focus on strengths
 - Show performance successes when advocacy is appropriate—reinforce the successes
 - Review the T² plan to redirect energies
- Embrace administrative processes
 - Find staff support to assist the champion
 - Provide tools to ease administrative burdens—travel, communication, seminar support

Reluctance for management to approve/endorse a champion

- Define responsibilities and role of the champion that engages the champion's management
- Get a formal agreement (if necessary) for the champion's involvement
- Provide administrative support to focus the champion on priority activities

Champion not located in the organization that will use the outcome of the guided T² effort

- Provide opportunities for the champion to engage and interact with necessary participants in the guided T² effort
- Create marketing information to boost the credibility of the champion in the organization receiving the outcomes of the guided T² effort

Lack of resources hinders effectiveness of champion

- Enlist the support and assistance of supporters in the champion's agency or other agencies as appropriate, to help identify and either avoid or surmount potential obstacles (legal, regulatory, budgetary, etc.) to successful guided T² effort
- A champion promoting an innovation may not recognize that a lack of any of the varieties of resources may be hindering progress. If the potential for a successful guided T² effort is high, approach the champion about what resources could make a difference
- Work with the champion to identify potential suppliers of the needed resources and identify a benefit-to-cost argument to show the advantage of supplying the resources
- Solicit decision makers to make the needed resources available
- Follow up with the champion to assess the impact of the resources and inform the suppliers of the resources of the impact
- Also refer to the identify and secure resources component

Turnover/loss of champion mid-effort

- Help the champion create or identify an “understudy” champion during the course of the project

- Capture knowledge of the champion prior to departure
- Get agreement from management to encourage the initial champion to consult with the new champion

Managing the executive-level champion

- Identify the executive's vision for the outcome of the guided T² activity
- Get the executive to identify priorities (if possible) for the guided T² effort
- Identify the executive's role to maximize effectiveness of the guided T² effort
- Provide support—marketing and communications to enhance visibility for the effort

Suggested Readings

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CHAPTER 4

Engage Decision Makers

Tier 1: Foundational/ Organizational Components

- Address Societal and Legal Issues
- Have an Effective Champion
- *Engage Decision Makers*
- Develop a T² Plan
- Identify, Inform, and Engage Stakeholders
- Identify and Secure Resources



1. Have the decision makers been identified and engaged?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
2. Have the resources been committed?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
3. Have possible barriers been addressed?
If yes, proceed to the next component.
If no, proceed to component discussion.

Organizational decision makers play two key roles in guided T². They assume ownership of the need, whether the need is a problem that must be solved, a deficiency that must be remedied, or an opportunity that should be pursued, and they control the resources required by the guided T² effort (Elrahman, 2003; Orcutt and AlKadri, 2009; Vowles et al., 2011). In practice, these two roles expand into multiple subroles that come into play at different times and to varying degrees depending on the specific technology being transferred and the characteristics of the organization or organizations involved. For example, identifying and defining the need can be straightforward when the problem presents itself (e.g., when customers demand real-time traffic information streamed via mobile devices such as smart phones).

Conversely, the need may be elusive and difficult to define such as when a new technology has the potential to change business practices (e.g., adding e-commerce capabilities where previously customer transactions were primarily in person and by mail). Often times, decision makers will be engaged before the guided T² phase of the Innovation Adoption Process begins. Having timely and detailed information about an innovation can help a decision maker understand how the innovation addresses the need and what resources will be necessary for successful T².

To move past the identification and definition stage, the need must make it to the top of the decision maker's priority list. Where the need falls in the hierarchy of priorities depends, of course, on competing priorities as well as the severity of the problem or the promise of the opportunity that this need presents. Priority of need also depends in part on the likelihood of a solution. If the need is pressing but a solution is at hand, a decision maker is likely to make it a top priority in order to "check it off the list." A guided T² effort makes a solution more likely.

Once a need has been defined and becomes a priority, the technology must be recognized as a potential solution. If the case has been made that the technology in question will solve a

Utah DOT Engages Decision Makers by Creating a Culture that Embraces Change

The Utah DOT (UDOT) has long been considered a leader in embracing innovations and successfully transferring technology through their organization. One of the keys to its success is **engaging DOT decision makers** early in the process of addressing needs, embracing innovation, and creating an organizational culture that encourages change. As John Njord, Director of the UDOT, states, “Innovation is a topic we discuss at every one of our senior staff meetings.” Decision makers at the DOT, especially upper management, are diligent about creating an environment that encourages reasonable risk taking to achieve innovation. A clear message is sent to employees—management will support them in their endeavors even if something goes wrong. The DOT also celebrates employee successes, which encourages employees to sustain that culture. Further, decision makers at UDOT are actively engaged in bringing innovation into the department. They provide the opportunity for several employees to attend the TRB Annual Meeting, more than they send to nearly any other national conference. Before they go, the attendees identify sessions that they plan to attend where they are most likely to collect ideas that are ripe for implementation. Employees must bring innovation back to the department. When employees return, they make a presentation of what they found to decision makers and identify one to two ideas that they are going champion for implementation. Decision makers are engaged because they are looking to apply best practices and proven technologies/innovations to better their operations. Those ideas become part of Utah DOT’s “TRB Scoreboard.” Senior management checks on progress 6 months after the TRB Annual Meeting to review progress on transfer activities for that technology. Thus, decision makers stay engaged through their responsibility to conduct follow-up/assessment of progress reviews, keeping in mind that they are likely to eventually provide resources towards T² efforts. (Interview with John Njord, Director, UDOT, on October 18, 2012; Lindsey, 2009)

problem or alleviate a deficiency in an organization (through careful attention to the activities outlined in the first two phases of the Innovation Adoption Process, i.e., defining the need and research and development), and if the decision maker has taken ownership of the need and regards it as a top priority, then the decision to move forward with the T² effort is likely to be a matter of education and communication. In many cases, particularly when the need is pressing and deployment of the technology will affect multiple business practices, there will be several decision makers, with their own responsibilities and perspectives concerning the need, the proposed technology, and the T² effort. One or more decision makers may emerge as innovation champions, applying their technical credibility, enthusiasm, and skills in persuasion to advance the solution. Considering the multiple components of successful T², a basic goal of education and communication activities is to guide decision makers so that they are on the same page and keep them on the same page throughout the T² effort.

Decision makers also control the resources needed to transfer a technology from its source to its destination. Resources include budgets, staffing, scheduling, training, equipment, materials and supplies, and more. Staging these resources and applying them to achieve T² may unfold over several phases and involve numerous stakeholders, and day-to-day management

Engaged Decision Makers Cross Functional Lines at Nissan to Bring Support for Auto Design

Faced with a need for increased innovation, Nissan hired western designer Jerry Hirshberg to lead Nissan Design International. Hirshberg's first assignment was to redesign light trucks at Nissan. He quickly realized that his team lacked the knowledge to develop novel design. Although organizationally forbidden at the time and culturally taboo, he **crossed organizational boundaries to engage in discussions with key decision makers** in marketing and sales. Unique input from these individuals helped Hirshberg's team realize that truck redesign had to begin with the cab of the truck and work outward (Hunter et al., 2012). The redesign was successful, as were the subsequent sales and marketing approaches. The broad success observed at Nissan Design International can be traced to leadership that saw the implicit value in engaging not only those in their own groups, but also decision makers who might shape the implementation of those designs (Hirshberg, 1999). Such input was critical at Nissan not only from an information-gathering perspective, but also to ensure that others within the organization would support the final designs. (Mumford and Hunter, 2005)

may be delegated to others (such as a T² champion). However, ultimate responsibility for the success of the effort remains with the decision maker because that is where responsibility for the need resides.

Guided T² is facilitated by an organizational culture that is open to change and innovation. An innovative culture means that organizational processes are tuned to handle change as a matter of routine. Staff members are expected to embrace new ways of doing things and are trained to solve problems. Decision makers play a key role in establishing and promoting an embrace of innovation in an organization's culture.

Considerations Regarding Decision Makers

What Actions Should Be Considered?

Identify the decision maker or decision makers

- Is one decision maker responsible for all significant T² decisions, or are two or more decision makers responsible for T²?
 - If two or more decision makers are involved, how are their responsibilities allocated? Will their roles be concurrent or sequential? Are there any reporting relationships between decision makers, and how will this affect the T² effort?
- Was the decision maker involved in the selection of the technology or solution to be transferred?

Engage the decision maker (or makers) in the T² effort

- Is solving the problem that the technology addresses a major responsibility of the decision maker?
- Does the decision maker have the necessary information regarding the technology to be transferred (including the need that the technology addresses, how this technology was chosen as a feasible solution, and by whom)?

- Is the decision maker involved in writing the T² plan? If so, to what degree? Does the decision maker have ultimate approval of the T² plan?
- What is the working relationship between the decision maker and the champion? Between the decision maker and the stakeholders? What effects will these relationships have on the T² effort?
- Does the decision maker have experience managing change in this organization, including surmounting bureaucratic obstacles, managing cross-unit or boundary-spanning teams and activities, effectively communicating with stakeholders, and minimizing risk exposure? Does the decision maker influence policy?

Obtain commitments for the necessary resources

- Are the resources required for successful T² understood by the decision maker, including financial, staffing, scheduling, training, communication, equipment, supplies, and so forth?
- Does the decision maker have the authority to commit the necessary resources? If no or partially, who else should be involved?
- What responsibilities does the decision maker have for evaluating the progress of the T² effort? For justifying T² resource expenditures?

What Are Some of the T² Challenges and Barriers Encountered by Decision Makers?

Overcoming barriers to T² often hinges on the actions of decision makers. By way of illustration, consider these categories and barriers to T²:

Contextual

- Little organizational support for innovation
- Leadership does not highlight technology needs or accomplishments
- Low investment in and funding for new technology and innovation

Organizational/Bureaucratic

- Organization policies, business processes, and standards work against change and innovation
- Organizational structure discourages cross sharing and collaboration
- Lack of management support and staffing

Legal/Risk

- No support for assuming any risk for testing and implementing new policies
- Design-build is not allowed or encouraged
- Inadequate formal process for new product evaluation

Communication/Knowledge Management

- Information is not readily shared across the organization
- Training and development opportunities are limited and underfunded

Many of these barriers arise because of past decisions about how resources were spent, what policies were established and enforced, what information was shared, and what training and development opportunities were available to staff.

What Are Some of the Tools or Strategies a Decision Maker Can Use to Overcome the T² Challenges Encountered?

Organizational decision makers and leaders can pave a smoother road for T² by promoting a culture of innovation and by employing some of the tools below when barriers are encountered or anticipated.

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Contextual

- Link T² projects to current program priorities
- Make T² and innovation a standard part of leadership meetings
- Align organizational mission and values to support innovation

Organizational/Bureaucratic

- Designate an innovation champion to lead T² activities
- Target specific funds for T² and deployment
- Set metrics that require change

Legal/Risk

- Work with legal staff to include contract terms that encourage innovation on specific projects
- Conduct scans to learn from other organizations
- Be willing to talk about “failures” and what was learned from them

Communication/Knowledge Management

- Use communication and information technologies and tools to get the message out
- Establish structured programs for continuous learning
- Senior management encourages and provides resources for strong internal communications

Suggested Readings

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- Orcutt, L. H., and M. Y. AlKadri, “Overcoming Roadblocks to Innovation: Three Case Studies at the California Department of Transportation.” *Transportation Research Record: Journal of the Transportation Research Board*, No. 2109, Transportation Research Board of the National Academies, Washington, D.C. (2009) pp. 65–73.
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Develop a T² Plan



1. Have the desired T² outcomes been defined?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
2. Has the plan developer been identified?
If yes, proceed to the next question
If no or unsure, proceed to the component discussion.
3. Have other parties been identified for involvement?
If yes, proceed to the next component.
If no, proceed to component discussion.

Tier 1: Foundational/ Organizational Components

- Address Societal and Legal Issues
- Have an Effective Champion
- Engage Decision Makers
- *Develop a T² Plan*
- Identify, Inform, and Engage Stakeholders
- Identify and Secure Resources

Developing a T² plan is a foundational component of guided T². Before one moves too far or too quickly into advancing toward deployment, some early planning is needed. Developing a T² plan serves a number of purposes:

- It is an opportunity to assess the current state of the market which the product will be entering
- It is a means to identify, anticipate, and ultimately determine a path around potential barriers
- It is a platform for determining where focus and priority are needed and in which areas less effort needs to be expended
- Finally, it is a basis for assessing the resources that will be needed to conduct T² efforts

The form, timing, formality, and even name of such planning efforts vary substantially among organizations. These variations may reflect an appropriate alignment with an organization's business and budgeting practices or the structure and staffing of the organization. As with many aspects of a T² effort, there is not a single “best” model, but instead, something that can be learned from multiple approaches. The following provides a sense of some of these variations.

Planning During Research and Development

In some organizations, the development of an implementation plan occurs while a project is still in the research and development phase of the Innovation Adoption Process. Part of the logic of developing a plan at this point is that it can also be used as the basis for determining whether the product should move forward to deployment (i.e., determining its feasibility for deployment). In this way, the implementation plan can be as much an evaluation and decision tool as a plan for addressing issues in the guided T² phase of the Innovation Adoption Process. Some organizations have found that this approach can be very effective, particularly in research

efforts where stakeholders and potential users are involved in the research and evaluation. The primary concern in taking this approach is that it may be difficult for the people who are conducting the research and testing to objectively evaluate the market potential of the product. Planning during the research and development phase could be done by members of the agency's technical advisory committee, which often includes end users of the technology.

Planning for Full Deployment

Another approach is to plan the pathway to full deployment. In such cases, the plan's emphasis and milestones are defined around deployment events (i.e., considering both the guided T² and deployment phases of the Innovation Adoption Process). This type of planning not only provides an evaluation of the actions needed to advance the product but can also be used to set targets for market penetration. As an example, such a plan may be built around a target of achieving deployment in 10 states in the first year, and 25 states by the end of the second year. Such a planning effort not only needs to consider the resources necessary to conduct outreach, training, demonstration, and other T² activities, but also needs to consider the resources needed to deploy the innovation. In cases where deployment may require the acquisition of new equipment or products, this plan would need to be closely coordinated with the capital budgeting process to ensure that the resources for implementation are available when they are needed. Many state highway agencies employ this level of planning when implementing winter maintenance technologies requiring the purchase of new equipment and tools.

Planning for a Deployment Decision

A third approach lies between the two previous examples. Such an approach focuses primarily on preparing for the guided T² components outlined herein up to the point where a deployment decision is made. Once again, the actual format and focus of this T² plan (sometimes referred to as a marketing plan) vary from organization to organization, but they are basically used to set the stage for the upcoming guided T² effort and activities (i.e., the other nine components in the guided T² phase of the Innovation Adoption Process). The T² plan may be very similar to a "triage process," in which the most critical needs are quickly identified and assessed in order to ensure that resources and energy are directed to where they can do the most good.

Considerations for the T² Plan

What Actions Should Be Considered?

Assess the desired outcomes of the plan

- Does the organization already have other tools, processes, or plans that provide some or all of the functionality of a T² plan?
- Is there a clear process in the organization for determining what technologies should be considered for further T² efforts (e.g., are they feasible?)
- How much information do the agency leaders need to make decisions about resource commitments of this size?
- How do agency leaders typically want to be presented with that information?

Determine planning responsibility

- Who has the ability to coordinate across organizations and stakeholder groups?

The NIH T² Plan for Accelerating Innovation and Commercialization

A continuing question for the National Institutes of Health (NIH) has been, “Why can’t we get innovations from the research labs to the public more rapidly with the high standard of safety and quality that the NIH requires?” This question took on more significance as several initiatives were implemented seeking federal agencies to streamline T² processes and measure goals. The NIH turned to comprehensive planning to make significant progress in this regard. The time-frame for the first NIH **Technology Transfer Plan** is 2013 to 2018. Objectives for the plan are focused on accelerating T² and the activities that enable commercialization of research results. The plan addresses solutions to increase the number and pace of effective T² and commercialization, and it highlights critical partnerships with non-federal entities including private firms, research organizations, and nonprofit entities. Importantly, the NIH determined it needed practical guidance to improve returns from R&D investments, including new products, industry partnerships, and invention disclosures. However, the NIH also understood the importance of streamlining processes towards effective T². The NIH planning will improve processes such as creating and implementing an automated work flow system, initiating reviews to reduce time to license technologies and to establish agreements and grant awards, and simplifying model agreements. This streamlining is significant so NIH T² professionals can dedicate more time to partnership activities. As the plan is accomplished, the NIH expects to accelerate formation of partnerships without sacrificing quality or safety and to increase the number of partnerships working in its institutes and centers. The plan is designed to be a win-win for NIH management as well as the laboratory; it describes intermediate to long-term investments in human capital development and information technology, e.g., expanded skill sets to better leverage limited T² resources, as well as setting out ambitious and achievable performance goals. The NIH anticipates that as a result of the plan, it will have reliable guidance to reshape its response to innovations, increase the effectiveness of the component institutes, and create efficiencies organization-wide.

[Available online] <http://www.ott.nih.gov/sites/default/files/NIH-TT-Plan-2013.pdf>

- What is the knowledge base of the stakeholder groups?
 - What motivates them?
 - How are they best informed and engaged?
 - What barriers are likely to be faced?
- Who has an understanding of the T² effort?
 - Experience in planning other T² efforts?
 - Knowledge of the components of guided T²?
- Who has the appropriate organizational awareness?
 - An understanding of the organization’s culture and workings?
 - Where is the information needed to develop the plan?
- Who has an understanding of the product?
 - Its capabilities?
 - Its benefits?
 - Where it can have the greatest impact?
 - Where the “bugs” may still be?

(Note: Depending on the timing of the guided T² effort, a champion may or may not already be identified for this innovation [see the section on champions]. If a champion has been identified, he or she should be fully engaged in reviewing and commenting on the plan. If a champion has not yet been identified, the plan may be a way to identify and build interest among potential candidates.)

Determine planning involvement

- External stakeholders may be excluded if the T² plan is an internal document
- The planner may solicit input from
 - Researchers
 - Program office leads
 - Representatives of stakeholder groups

What Are Some of the Challenges to Developing a T² Plan?

Determining process versus substance

The greatest danger of T² planning is what some may consider its greatest success. Having an effective T² planning process is an excellent goal, but if the organization's emphasis and objectives are primarily placed on that process and not on the substance of the planning effort, its value may never be realized. Remember:

- The plan is a *tool* toward deployment
- The plan is not the final product

Lack of connectedness

- One of the dangers of any planning effort is that, once completed, the plan will not be used.
- This is not because the plan is ineffective, but because it is not clear how the plan is connected to the organization's other business processes.

What Are Some of the Tools or Strategies to Overcome the Challenges to Developing a T² Plan?

When choosing a planner, consider those with a vested interest in the success of the innovation

- The research team that developed the product
- The program staff that want to operationalize it
- The field staff and stakeholders that will need to put it in place

To improve the likelihood of success of a T² plan:

- Look beyond the T² plan itself at the overall guided T² effort
- Plan within the organization's strategic and business goals

Identify, Inform, and Engage Stakeholders



1. Have source stakeholders been identified?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
2. Have recipient stakeholders been identified?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
3. Have stakeholders reached a mutual understanding of the need and potential solution?
If yes, proceed to the next component.
If no, proceed to component discussion.

Tier 1: Foundational/ Organizational Components

- Address Societal and Legal Issues
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- Identify and Secure Resources

There can be numerous stakeholders in the Innovation Adoption Process, each with a unique perspective on the need or problem that the technology addresses. The T² definition offers two ways to classify core stakeholders: those who are the source of the technology, and those who are the recipients of it. When the need stems from an organizational problem or deficiency, the process is likely to start with recipient stakeholders. They search for a solution or remedy until they pull in the technology that satisfies the need. The process can also begin with source stakeholders. When the source stakeholders have a technology that meets a need that recipients may or may not recognize, their task is to push the technology to the recipients. In either case, the question is how to make the process more efficient for both recipient and source stakeholders.

The guided T² effort benefits when source and recipient stakeholders are aware of each others' needs, resources, decision processes, knowledge and skill levels, current work methods, and technologies. Numerous authors have proposed strategies for facilitating communication and knowledge sharing among stakeholders. Among the strategies recommended by Rogers (2002) were creating boundary-spanning units, transplanting personnel, and forming network relationships linking R&D organizations and receptor organizations. Each of these strategies places source and recipient stakeholders into close working relationships—these purposeful interactions transfer relevant knowledge and information while helping each party to understand the circumstances and perspectives of the other. Other authors have emphasized the importance of communications and knowledge sharing among stakeholders, including Desouza et al. (2009), who listed dialogue with all stakeholders and use of social networks among key elements for successful diffusion, and Bonini et al. (2011), who listed among their implementation principles effective communications, broad involvement of the field, and a supportive culture of innovation.

Fostering stakeholder interactions has figured prominently as a way of promoting T^2 in the transportation community. Beginning in 1987, the Strategic Highway Research Program (SHRP) relied on task forces established by the American Association of State Highway and Transportation Officials (AASHTO) in cooperation with the Federal Highway Administration (FHWA), as does SHRP's successor, SHRP2. Task forces have members from states that take the lead in implementing various SHRP and SHRP2 products, following the AASHTO guidebook that prescribes the roles and responsibilities of team members. FHWA's Highways for LIFE initiative, intended to accelerate innovation in the highway industry, created the Technology Partnerships Program to promote partnerships to test and demonstrate new technologies in real-world settings (Zirlin, 2009). The U.S. Domestic Scan Program gives transportation professionals the opportunity to gain firsthand knowledge of best practices and innovative technologies implemented by other states (Casey and Casey, 2009). These scans are viewed as valuable by participants not only for the opportunities to see technologies in use elsewhere, but also to learn about the T^2 practices of other agencies, the barriers they encountered, and the lessons learned.

Interactions and knowledge sharing help stakeholders identify and understand technologies that fit the particular needs that motivated the searches for solutions. Solutions for an organization may reside internally within other organizational units, externally as might be revealed by a domestic scan, or may require original research such as could be accomplished through a networking relationship with an R&D partner organization. When the technology is used successfully elsewhere, and particularly when a domestic scan or peer exchange determines that it is being used successfully by a comparable organization, then the important questions "Does it work?" and "Could it work here?" can potentially be answered in the affirmative. The deep understanding that comes from stakeholder interactions should greatly facilitate specific T^2 activities. At that point, the decision to begin the T^2 effort is paramount.

Informed and Engaged Stakeholders Foster Use of Structural Design Methodology

Load and Resistance Factor Design (LRFD) is a design methodology used by structural engineers for the design of steel structures and the geotechnical design of highway substructure features. AASHTO introduced LRFD in 1994, envisioning full implementation by all state departments of transportation (DOTs) by year 2000. The acceptance of LRFD occurred more slowly than anticipated and full implementation did not happen by the target year. The barrier was that LRFD represented a significant difference in design practice from the previous standard and was not well received by many engineers in the highway structures industry (Withiam, 2003). Accordingly, AASHTO and the FHWA decided to better inform stakeholders, the structural engineers responsible for incorporating LRFD in their agencies, through several initiatives, in particular the development of two LRFD courses: one for superstructure design and the other for substructure design. During the courses and through subsequent surveys, FHWA gathered data about reasons for delayed implementation by the state DOT stakeholders (Withiam, 2003). As a result of the findings, the *LRFD Specifications* were revised with new content that removed the design practice barriers and helped overcome the reservations of structural engineers. NCHRP, FHWA, and state DOTs, particularly Florida, Pennsylvania, and Washington, led the effort. ***By informing and engaging stakeholders in the process and by gathering their input and educating champion states, public and industry agencies worked to evolve the specifications and importantly to accomplish effective T^2*** (Withiam, 2003).

Stakeholder Roles in Guided T²

With the onset of guided T² activities in the Innovation Adoption Process, the number of stakeholders involved in T² is likely to increase and their roles are likely to diversify. Some decision makers may have been involved in the Innovation Adoption Process since the initial search and evaluation phases, particularly if they have ownership of the problem, but other decision makers, such as top executives, may not have been. Before green-lighting a T² initiative and allocating the required resources, decision makers may need to be informed by internal and/or external stakeholders about the technology-need fit. If a champion has not already emerged, one will have to be found. A transfer agent may be advisable if the source is external and the technology is unfamiliar to internal stakeholders. Work unit managers and other end users may be involved as participants or observers in demonstrations, showcases, technical assistance education, process/outcome evaluation, and other T² activities.

Establishing trust among stakeholders is vital to effective knowledge sharing and cooperation. Stakeholders enter the scene with their individual perspectives on the problem, the potential solution, and the resources required to transfer the technology. Stakeholders may differ in their views on the probability of successful transfer, the magnitude of change to current practices if the technology is deployed, the value of current practices and whether they should be maintained, human resource implications if the technology is deployed (knowledge and skill needs of current staff, whether staffing will increase or decrease post-deployment), and more. Some recommended strategies to promote trust among stakeholders include R&D partnerships and alliances in which source and recipient stakeholders jointly formulate the problem statement, T² teams that are formed to design and lead the transfer process, and a leader who reinforces cooperation among team members (particularly important in competitive organizational cultures).

Engaged Stakeholders at FAA Ensure Input Heeded by Technical Teams

During the 1990s, the FAA collaborated with the University of Dayton, the Port Authority of New York and New Jersey (Port Authority), and Engineered Arresting Systems Corporation (ESCO) to study how Runway Safety Area (RSA) requirements might be realized at runways without sufficient area for full compliance. A new technology emerged from this collaboration that safely arrests overrunning aircraft using crushable concrete placed at the end of runways (U.S. DOT, FAA, 2011, 2012). That technology was commercialized as Engineered Material Arresting System (EMAS) and marketed by ESCO. FAA had the job of transferring the technology to airport user organizations that could potentially use it to improve their RSAs. In its early T² efforts to ensure that the technical need of airports would be satisfied, the **FAA involved stakeholder organizations** in the early implementation of the new technology. The Port Authority loaned one of its senior engineers to the FAA to provide customized input to facilitate the transfer of the technology. This valuable input included addressing implementation issues that were critical to the ultimate success and usability of the technology by airports. The stakeholder was able to provide a practical example defining the need for the technology and the resources required to transfer that technology in the field, as well as provide technical input to FAA. Currently, EMAS is installed at 63 runway ends at 42 airports in the United States, and there are plans to install three EMAS systems at three additional U.S. airports. Also, to date, there have been eight incidents where EMAS has safely stopped overrunning aircraft with a total of 235 crew and passengers aboard those flights.

Considerations Regarding Stakeholders

What Actions Should Be Considered?

Identify the stakeholders

- How many stakeholders are there?
- Which stakeholders represent the source of the technology and which represent the recipient organization?
- How do stakeholders relate to the T² decision maker(s) and champion?

Assess the stakeholders' perspectives on the problem and the solution

- What are the perspectives of individual stakeholders on:
 - The need or problem?
 - The technology identified as a potential solution?
 - Resources required for successful transfer?
 - Probability of successful transfer and definition of success?
 - Implications for current and future practices if fully deployed?
- What are the education and communication needs of stakeholders concerning this T² effort?
- What are the levels of knowledge sharing, trust, and cooperation among stakeholders?

Define the roles of various stakeholders in the T² effort

- Define each stakeholder's responsibilities for T² activities
- What can be done to promote knowledge sharing, trust, and cooperation among stakeholders?

What Are Some of the T² Challenges and Barriers Encountered by Stakeholders?

Overcoming T² barriers often hinges on the actions of stakeholders. By way of illustration, consider these categories and barriers to T²:

Contextual

- Little organizational support for innovation
- Lack of political support for new initiatives or risk
- Legacy technologies/practices foster inertia

Organizational/Bureaucratic

- Organization policies, business processes, and standards work against change and innovation
- Organizational structure discourages cross sharing and collaboration
- Contracting and procurement practices thwart new approaches

Communication/Knowledge Management

- Information is not readily shared across the organization
- No emphasis on "social contagion," a lack of opportunities for direct contact, observance, and influence of early adopters
- Information does not get to the right people or put in a format that people can use

Internal Stakeholders

- The researchers aren't listening to the users
- Users aren't deploying solutions developed by R&D
- Staff lacks the skills to either promote or seek out new ideas

External Stakeholders

- External partners are not viewed as customers or end users
- There is limited communication between the state DOT and outside organizations

Many of these barriers arise because of past decisions about how resources were spent, what policies were established and enforced, what information was shared and with whom, and legacy practices.

What Are Some of the Tools or Strategies a Stakeholder Can Use to Overcome the T² Challenges Encountered?

Source and recipient stakeholders can pave a smoother road for T² by employing some of the tools below when barriers are encountered or anticipated.

Contextual

- To the extent possible, use existing systems to advance T² priorities
- Create mechanisms for knowledge sharing (newsletters, library, and network teams)
- Use organizational resources and programs to reinforce T², such as awards, rewards, prizes, and innovation competitions

Organizational/Bureaucratic

- Designate an innovation champion to lead T² activities
- Give the program office directors greater ownership for R&D and T² programs
- Create a common sense of purpose within the organization (“one DOT”)

Communication/Knowledge Management

- Offer “brown bag” or “just-in-time” training to highlight innovations
- Establish social media links within the organization focused on knowledge sharing (refer to Educate, Inform, and Provide Technical Assistance component)
- Form partnerships with local universities

Internal Stakeholders

- Mentor/coach new T² champions
- Actively engage user community in the entire innovation process from R&D to deployment
- Provide leadership by senior management in bringing users and researchers together

External Stakeholders

- Develop a network of external partners that share an interest in the technologies that are being promoted
- Invite external partners to participate in technical working groups to identify technology needs, R&D candidates, and deployment opportunities
- Provide conferences/expos to link to external stakeholders and potential partners

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- Zirlin, J., "Bringing Innovations to Market." *Public Roads*, Vol. 72, No. 4 (2009).

Identify and Secure Resources



1. Is the innovation fully researched and understood?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
2. Have resources been secured/committed?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
3. Have possible barriers been addressed?
If yes, proceed to the next component.
If no, proceed to component discussion.

Tier 1: Foundational/ Organizational Components

- Address Societal and Legal Issues
- Have an Effective Champion
- Engage Decision Makers
- Develop a T² Plan
- Identify, Inform, and Engage Stakeholders
- *Identify and Secure Resources*

Products of transportation research or other innovations that are feasible solutions to needs require actions by people and organizations to ensure change in practice or realization of benefits. These actions require a variety of resources to get the job done. Identifying and securing sufficient resources for T² is a fundamental component in the guided T² effort leading to the product's adoption, deployment, and use.

The fact that resources are needed to accomplish T² is common knowledge among research managers, T² implementation practitioners, and many technical staff members of user organizations. Yet, having the appropriate resources at hand for T² tasks is a significant accomplishment, and one that contributes to success. To enhance the likelihood of success, this guide is designed to assist in

- Identifying the types and extent of resources required and their sources
- Providing strategies to illustrate the need for and importance of the resources to stakeholders and decision makers to enable them to commit the resources

Categories of Resources

In keeping with the definition of T² provided in Chapter 1, resources are tangible and intangible assets used to bridge the gap between identification of a feasible product and its deployment. Resources are diverse and for this guide are grouped into four categories:

- Existing infrastructure for T² implementation/deployment—the operational environment, tools, and techniques that foster innovation
- Human—the people participating in moving the product from the source to the recipient, either directly or indirectly, including the influence people wield or confer

Multiple Types of Resources Foster Local Road Safety in Michigan

In 2004, the Michigan DOT (MDOT) kicked off its Local Safety Initiative to assist local agencies in Michigan to reduce crashes on the local road network. MDOT's goal was to transfer knowledge and resources to local agencies to build their technical capabilities and ultimately to reduce the number and severity of road crashes. Useful resources for T² are more than financial. MDOT's creative approach was to **provide resources in the form of direct engineering support, training, and several safety software tools**. MDOT continues to build partnerships with local agencies by teaching their staff how to access and analyze crash data, conduct field reviews, and determine appropriate countermeasures. MDOT also directs local agencies toward funding sources. By providing these resources as part of the transfer of safety technologies, MDOT is making progress towards reducing crashes on Michigan's local road network. (Interviews with Tracie Leix, MDOT, on July 10, 2013, and Dale Lighthizer, MDOT (retired), on July 10, 2013)

- Fiscal—the funds needed to pay for the costs of T² activities
- Materials and facilities—the physical items required to conduct T² activities, especially for education, training, and demonstrations and showcases, including samples of the technology being transferred, supplies and equipment, marketing and communications materials, and sites and locations

Identifying the Resources Required

Where to Start

Initially, practitioners should do some background work to become informed. It is necessary to have a grasp of the product, what it does, how it provides solutions to needs, its characteristics, and other aspects of the innovation. It is not essential to know as much about the product as the inventor or researcher, but having an understanding of why it is important to the receiving organization is fundamental. Additionally, it is important to understand in some measure the processes that will take over once the T² is accomplished. It is important to be familiar with the context of the technology, that is, in terms of the Innovation Adoption Process—the need, the research and development, and the intended deployment. Having this knowledge will assist in determining the required resources.

Following this background assessment, the process for identifying resources moves through the following steps:

- Scan to see if there are any established practices (elements in a T² or innovation infrastructure) that can be used—this prevents duplication of effort and piggybacks on lessons learned in the past
- Determine and name the participants and their roles and responsibilities
- Spread the net wide to locate funding options
- Assess the need for materials to accomplish the T² and necessary facilities or locations where the T² will occur

Use Existing T² Infrastructure if Available

Are there existing proven and accepted practices to accomplish T² in the organization, and, if so, what are they, and can they be applied to the current effort?

There may be some infrastructure in existence that will help facilitate T². Usually such infrastructures are built through experience from past T² efforts or are part of the organization's effort to foster innovation. The practices used in the past will have been institutionalized to various degrees, providing tools, networks, and processes that can be used for a new T² effort. Often these established practices provide for other necessary resources.

Existing practices to consider might include the following:

- A T² plan that can provide a roadmap for required resources and make resource identification markedly easier (See T² Plan Section)
- Implementation or deployment plans, plans for action following the T² work, which will help determine the extent of the T² effort
- Dedicated funding for T²
- Staff assigned to the job of T² in the source and/or receptor organizations
- Communications plans and standardized communication vehicles to foster T²
- Stakeholder groups
- Organizational functions or policies fostering innovation

Any of these elements of an existing infrastructure are resources that can be applied to a new T² effort. Scan for such elements; determining their applicability and using them will prevent duplication of effort and will likely save time and other resources. If there are no established, useful practices to assist in T², or those that are applicable are already part of the T² effort, next assess the needed human resources.

Identify the Necessary Participants

Who needs to be involved in a T² effort? Consider the types of talent required to get to the decision point for deployment of the technology. For most of the participants' roles, it will be necessary to identify the specific individual(s). The roles are the following:

- **Champion.** This is the primary advocate for the technology who effectively and persistently seeks its adoption and deployment, is technically competent, and has credibility with peers and prospective users. (See Champions Section) This person also may fill the role of one of the technical experts, as described below.
- **Technical experts.** These are the individuals in the source and recipient organizations who understand the technical aspects of the technology to be transferred and are available to
 - Assist in developing marketing and communications content
 - Develop curricula content and participate in training and education sessions
 - Develop content and participate in demonstrations and showcases
- **Stakeholders.** These are the individuals in the source and recipient organizations who have a vested interest in successful deployment of the technology and its benefits. There may be numerous stakeholders such as the following (See Stakeholder Section):
 - Technology creators/researchers and developers who can provide technical expertise for T² support, as needed
 - Organizations (internal and external) who provide fiscal or other assets to accomplish the T²
 - Organizations (internal and external) that will be affected by the receiving organization's change in practice when the product is deployed and who have employees that will want to be knowledgeable about the function and use of the product (e.g., other divisions of the recipient organization, outside partners, and professional or trade associations)
 - Users who will be applying the new product to their work practice
 - Early adopters, a special category of user: "The early adopter decreases uncertainty about a new idea by adopting it, and then conveying a subjective evaluation of the innovation to near peers through interpersonal networks" (Rogers, 2003, p. 283). Identifying early adopters will assist in targeting marketing and communications activity as well as training and other hands-on activities to people who have a higher likelihood of influencing the decision to deploy the product.

- **Administrative staff.** These individuals are important contact points for the T² activities and have access to decision makers and stakeholders (e.g., fiscal personnel, decision maker's assistant, facilities scheduler, and public affairs staff).
- **Decision makers.** These are the people who assume ownership of the need and its solution, and who control the resources required by the T² effort. They have the authority in the organization to either foster or impede the progress of the product's advancement toward deployment. Decision makers are often middle managers responsible for supplying staffing, funds, facilities, and materials. They also may be executives specifically interested in the outcome of applying the innovation. It is particularly important to identify the individual(s) who determine(s) the "go ahead" decision for deployment so T² efforts can support and speed up the decision-making process. (See Chapter 4.)
- **Influential decision makers and stakeholders.** These individuals can positively or negatively affect the job of T² through lending or withholding their support. These influential people can enhance or detract from the value of the technology being transferred. Their influence generally rests in the importance of their position and the credibility that they possess. Positive influence is an asset and a resource to be used wisely.
- **T² practitioners and/or transfer agents.** These are individuals in the source or receiving organizations who have the responsibility to foster and accomplish T² activities. If there are personnel resources available to accomplish the product's transfer, identify them and use their knowledge and expertise.

Identify Funding Sources

There are three primary areas for funding the T² effort:

- The organization that is the source of the product, e.g., researcher, product owner, licensee, or vendor
- The organization that is the recipient of the product including the research or innovation group facilitating T², the program office, and field and operational offices
- Third-party stakeholders such as academic institutions, contractor organizations, associations, and other government or industry partners. (FHWA and LTAP/TTAP centers may have funding to assist with T² efforts.)

The T² plan, if available, should provide direction for identifying funding for the T² effort. However, if there is no T² plan or there is a need for strengthening the approach to funding the effort, do not hesitate to take action to ensure the availability of these important resources.

Working with the product champion, appropriate decision makers, and other stakeholders, identify the potential sources of funds available for the T² effort. Questions to ask are the following:

- Are there available funds from the originator of the product to foster its adoption?
- Is the product a result of national research and development efforts, and are there T² funds available from the originating program, e.g., SHRP2, AASHTO TIG, and FHWA Highways for LIFE?
- Are there T² or implementation funds available from the research unit, particularly state planning and research federal-aid funds?
- Are there other federal-aid funds such as safety or transit funds available?
- Are there program funds available for demonstrations and prototypes?
- Can the T² effort be done with leveraged funds from cooperative research programs?
- Are there any organizational matching funds options that can be an incentive to involve stakeholders?
- Are there any matching funds programs from third-party organizations?

- Are stakeholder organizations willing to contribute funds to the T² effort?
- Does the local LTAP and/or TTAP center have funding available for T² efforts, or are financial resources available from the National LTAP Association including their working groups?
- Does FHWA have resources available to assist with T² efforts?

Define and Locate Required Materials and Facilities

T² requires communications and often education and training opportunities as well as hands-on events such as demonstrations and showcases. Based on the T² plan or a communications plan, determine the types and estimated costs for production of necessary communication and education tools, e.g., brochures, videos, webinars, and training course materials, as well as conducting events such as training seminars. Additionally, depending on the product to be transferred, determine the requirements for materials and supplies for demonstrations or showcases including the sample products under consideration. Furthermore, identify the locations and facilities necessary for the T² effort: training facility, demonstration site, or showcase facility.

Securing the Resources

Securing the necessary resources is directly dependent on engaged decision makers and informed and engaged stakeholders. (See Decision Maker and Stakeholder Sections) Consider the following broad steps to create decision maker confidence in the effort and to inform and engage the stakeholders:

- Communicate and inform each target group and tailor messages to fit the audience
 - Provide a clear and concise description of the product
 - Describe the T² effort and why it is important
 - Describe in detail the T² resources required, their cost, and when they are needed
 - Provide clear benefits and value of the T² effort
 - Communicate progress of T² efforts
- Do not fail to ask decision makers for the specific resources needed
- Provide a means to monitor and track T² efforts

What Are Some of the Challenges to Identifying and Securing Resources to Accomplish the T² Effort?

A host of challenges can arise regarding resources. Some of these are the following:

- Weak or no T² plan
- Decision maker(s) is(are) a bottleneck
- Insufficient resources
- No communications expertise
- No technical expertise in the receiving or user organization
- Lack of consensus for T² in stakeholders

What Are Some of the Tools or Strategies to Overcome the Challenges Encountered?

If there is a weak or no T² plan

- Provide guidance to the champion and the decision maker(s) to develop a workable plan (See T² Plan Section)
- Work with the stakeholders to strengthen the plan and fill in gaps

- Determine whether there is a T² plan used by another organization that would be willing to share it as an example
- Find out if there are T² strategies recommended by the source of the product

If the decision maker is a bottleneck

- Determine the perceived barrier and address it
- Better inform and engage the decision maker through effective communications
- Solicit peers to endorse the T² effort with the decision maker
- Enlist support of the champion to sway the opinion of the decision maker

If there are insufficient resources

- More accurately define the resource need and approach stakeholders for sponsorship
- Determine whether stakeholders or partners will supply materials at no cost or in-kind services to defray costs for communications, education and training, supplies and materials, demonstration sites, and facilities or equipment
- Redefine the magnitude of the T² effort

If there is no communications expertise

- Hire the necessary marketing/communications talent to assist in the T² effort
- Seek assistance from LTAP/TTAP staff
- Enlist others from the organization that have the talent such as public affairs or press office
- Determine whether there are similar T² efforts in other organizations that will share their communications plan and materials as examples

If there is no technical expertise in the receiving or user organization

- Get technical staff informed and educated, especially the potential early adopters
- Bring in expertise from outside the organization, but do so in a manner that retains the ownership of the transferred product with the ultimate user

If there is a lack of consensus for T² in stakeholders

- Better inform the stakeholders to get them “on the same page”
- Create means to involve stakeholders in the T² effort
- Identify the cause of divergent opinions and address them if possible
- As a last resort, acknowledge that the T² effort may have to go forward without a stakeholder or partner

Suggested Reading

Rogers, E. M., *Diffusion of Innovations, 5th Edition*, Simon & Schuster, Inc., New York, NY (2003) pp. 281–285.

Conduct Demonstrations/ Showcases



1. Should this innovation be demonstrated to a live audience?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
2. Is the audience chosen and able to assemble?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
3. Are take-home materials available for the audience?
If yes, proceed to the next component.
If no, proceed to component discussion.

Tier 2: Knowledge Building

- *Conduct demonstrations/showcases*
- Educate, inform, and provide technical assistance

Description of a Demonstration/Showcase

A demonstration project or showcase is

an information exchange mechanism that can reduce or eliminate the financial, professional, and political risk public agencies face when committing hard-to-come-by funds implementing technology when little or no practical field experience exists. The process allows hands-on experiences for the participants who interact with knowledgeable peers and others experienced in the technology application. (Harder and Benke, 2005)

A demonstration project is considered another successful strategy for facilitating T², especially demonstrations that have hands-on learning.

While demonstrations and showcases are most often thought of as events that are attended in person, technology may allow them to be conducted remotely. If a demonstration project is broadcast in the proper digital format, it may be viewed remotely via Skype, iPhone, or smart phone. The demonstration can also be recorded in the appropriate digital format for viewing at a later point. If not live, participants may have challenges with the hands-on aspect or asking live questions, but asking questions remotely is a possibility.

Note that the demonstrations or showcases described here are part of the Innovation Adoption Process as defined in this guide. They occur **after** testing and evaluation in the R&D phase of the Innovation Adoption Process. For example, once a need has been identified as a problem to be solved, and a solution has been found internally, externally, or through research, an agency must show that the solution is feasible to implement within their organization. This might involve testing within an agency to demonstrate effectiveness in solving the identified problem. Sometimes demonstrating feasibility involves the development of a prototype or early implementation of the innovation as a pilot project. These activities all contribute to answering the question “Can it work here, in this agency?” These activities are briefly described in the blocks representing the phases of “Need” and “Research and Development” in the Innovation Adoption Process shown in Figure 1-3.

Demonstration of Feasibility Assessment—Caltrans' Pilot Vehicle Assist and Automation Program

A case example from the California Department of Transportation (Caltrans) shows how a rigorous pilot testing process can help move a potential innovation—vehicle assist and automation (VAA) technology applied in a transit setting—toward more widespread deployment by demonstrating its practical feasibility.

The Innovation

VAA is a particular application of the more generally defined Intelligent Transportation Systems (ITS) technology for vehicle control and is being applied in this case example for transit bus guidance. These technologies can help the driver maintain lateral control of the bus, for example, for vehicle guidance and precision docking. With fully automated control of both longitudinal and lateral movement of the bus, platooning and full automated operation are possible.

Caltrans' pilot program for transit bus guidance is applying VAA. In this program, two VAA sensing technologies are being used: magnetic marker sensing and a differential global positioning system (DGPS) with inertial navigation sensors (INS). In magnet systems, the bus follows a trail of magnetic nails, disks, or tape embedded in, or on, the pavement. In DGPS systems, on-board equipment guides the bus movement using differential GPS to determine the location and an on-board map to determine the path.

The Pilot Test

U.S. DOT and FTA seek generally to promote the development of innovative ITS applications. Through university-based research, initial small demonstration projects, and limited international applications, VAA has been shown to be consistent with the agencies' aims and potentially to meet an important **need**. While initial research has shown that VAA technologies have significant promise, the U.S. DOT perspective was that in most cases, the technologies' full technical feasibility and benefits had not yet been adequately quantified. Therefore, a pilot program was initiated to demonstrate the benefits of VAA applications for full-size public transit buses in revenue service.

The main objectives of the pilot program are to determine the technical feasibility, benefits, and costs of VAA in revenue service. VAA in this application has been shown to be a mature technology that has the potential to

- Improve vehicular safety in traffic
- Reduce travel times
- Provide better ride quality and improved passenger cabin safety
- Permit narrower dedicated bus lanes, and thus reduced right-of-way
- Aid level boarding
- Create narrow horizontal gap at boarding platform to comply with Americans with Disabilities (ADA) requirements

Caltrans and other **stakeholders**—Alameda County Transit (AC Transit), Lane Transit District (LTD) in Oregon, the University of California Partners for Advanced Transit and Highways (PATH) Program, and several private sector companies—agreed that these potential benefits could be realized with the application of VAA technologies along AC Transit’s M line, including the toll plaza, and LTD’s Franklin EmX Bus Rapid Transit (BRT) route that includes a dedicated bus lane with eight stops and two terminal points.

Following the identification of a need to pilot test VAA, **resources** were made available from FTA for tailoring VAA to the test situation and test bus instrumentation. Additional funding was provided for this project and supplemented with resources from Caltrans, AC Transit, and LTD. **Decision makers** at Caltrans, AC Transit, and LTD had to approve the installation of the technology in their buses.

Champions at AC Transit and LTD promoted the use of the VAA technology. In the case of LTD, the transit bus trainers served as champions before introducing the technology to the bus operators. The trainers themselves completed an extensive **training program** on the use of the technology, safety and operational benefits, override capabilities, and test runs, which convinced them of the viability and safety of operation. This exposure to the technology was vital to the effort, because, from a human factor standpoint, convincing the trainers (and bus drivers) to relinquish control of the wheel and allow the technology to provide lateral guidance was difficult. Once the trainers became convinced, they became champions, subsequently training bus operators in the operation of the technology. Anecdotally, the Caltrans project manager indicated that although initially the trainers and operators were quite nervous about the technology, they are now advocating for all buses to be equipped with VAA technology.

During the pilot, with VAA-equipped buses running in revenue service, quantitative data are being collected on lateral accuracy, passenger counts, and dwell time to characterize significant aspects of system performance, along with qualitative measures (such as ease-of-use, human-machine interface design, and ride comfort) gathered through interviews with drivers and passengers.

The Results

At the end of 2013, the pilot test was not complete but results have been promising. The in-service demonstration is providing evidence to both operating personnel and transit users that this VAA technology can be move from research to practical application. In designing an adequately funded pilot, recruiting champions among the demonstration’s participants, and providing effective training, Caltrans and its partners exhibited good guided T² practice and enhanced the likelihood of the pilot’s success.

A demonstration or showcase undertaken as part of the guided T² phase of the Innovation Adoption Process is different in purpose. At this point, the innovation will have been determined to be feasible, available, and ready for use. Documentation of sufficient evidence of the benefits must also be available. The questions “Does it Work?” and “Could it Work Here?” have been answered in the affirmative, so the innovation should not require further development, testing, or evaluation. A T² demonstration or showcase should answer several different questions:

- What will be different or what will change as a result of deploying the innovation throughout the DOT?
- What can be learned from the demonstration/showcase that can be applied to full-scale deployment?
- What are crucial elements to success of the demonstration and how can these be identified and transferred to full-scale deployment?

Thus, demonstrations or showcases for T² can display the merits of a product or service to a number of different audiences:

- Upper management, decision makers, or other stakeholders to obtain support for deploying and implementing an innovation
- Technical staff or other “end users” within a DOT for whom this product/technology may be new
- Local agencies looking to implement a new technology that has been utilized on the state level
- Other states looking for solutions to their problems (T² between agencies)

PennDOT Showcases Tow Plows

In 2012, PennDOT adopted the tow plow as its newest piece of storm-fighting equipment on Pennsylvania roads. A tow plow is a snow plow towed by a plow truck. When combined with a standard V or swivel blade front plow, this device (manufactured by Viking-Cives, LTD) increases plowing width to 25 feet, or two full lane widths. When activated, the wheels of the tow plow turn up to 30 degrees to the right, causing the tow plow to steer out to the right of the plow truck. The tow plow was piloted successfully in 2009 on a major Interstate. According to one county maintenance manager, “The tow plow allows the operator to clear two lanes simultaneously, reducing route time by half. This enhances productivity and saves fuel.” He added it can be equipped with tanks and/or hoppers to spread liquid, granular, or a mix of material, and also can be used as a pre-treatment trailer. He noted that the feedback from early adopters of this technology was very positive.

At PennDOT’s annual maintenance managers meeting in June 2009, the tow plow was a featured technology that was **demonstrated** and **showcased**. It was available for managers to inspect, discuss, and try out during this 3-day meeting. The benefit of the showcase was that attendees could see and experience how the tow plow works, get technical advice on how it would apply to their particular user environment from trusted peers in highway maintenance, and get product information from the technical experts available at the event.

Demonstration of the Fitch Barrier Proves Potential to Save Lives

John Fitch, legendary race car driver and inventor was so convinced that his barrier system could successfully save lives on the highway that he **insisted on a demonstration during which he tested the innovation on himself to demonstrate its effectiveness**. Following this demonstration, the Fitch Universal Module System (Fitch Barrier) gained more widespread acceptance as an impact attenuator designed to reduce damage or injury from motor vehicle collisions by absorbing or redirecting the kinetic energy of vehicles colliding with the attenuator. The Fitch Barrier uses sand- or water-filled plastic barrels set in a triangular array with less sand or water in the front barrels and more sand or water in the barrels toward the back of the array. The kinetic energy of a colliding vehicle is dissipated by the scattering sand or water, allowing the vehicle to decelerate quickly but smoothly. The Fitch Barrier's popularity is due to its low initial cost, its low maintenance costs, its ease of setup, and most importantly its success. The Fitch Barrier is estimated to have saved 17,000 lives since its implementation in the late 1960s. The deployment of the Fitch Barrier was aided by two key T² elements: **an effective champion and a successful demonstration**. (Grinnell, 1993)

Considerations for Conducting Demonstrations/Showcases

What Actions Should Be Considered?

To conduct a successful T² demonstration project or showcase, there are eight critical elements or actions:

Involve innovation champion (refer to Chapter 3 for more details)

- Innovation champion should take a lead in helping to organize and run the demonstration project.
- Often, there may be several champions involved. A technical champion should be available to answer technical questions and take a lead on organizing proper responses to technical issues that may arise during the demonstration. There may also be a champion from upper management/decision maker levels that would lend support to the demonstration project to show other management level employees that the DOT has bought into the innovation.

Define audience

- Upper management to obtain support for implementing an innovation
- Technical staff within a DOT for whom this innovation may be new
- Local agencies who are looking to implement a new technology that has been utilized on the state level
- Other states looking for solutions to their problems (T² between agencies)

Establish objectives

- How are you communicating the benefits to the targeted audience?
 - Plan the event with the target audience in mind

Iowa DOT Successfully Demonstrates Several Accelerated Bridge Construction (ABC) Technologies

The U.S. 6 bridge replacement over Keg Creek in Pottawattamie County utilized several innovative methods incorporated into a single bridge project to reduce bridge closure time: prefabricated superstructure and substructure systems, ultra-high-performance concrete (UHPC), self-consolidating concrete (SCC), and fully contained flooded backfill. The Iowa DOT partnered with the FHWA and the Strategic Highway Research Program 2 (SHRP2) to promote the innovations used in the US 6 over Keg Creek bridge replacement project through a **1-day showcase** in Council Bluffs, Iowa. The showcase included presentations by representatives of the FHWA, Iowa DOT, SHRP2, Iowa State University, HNTB Corporation, and the construction contractor. The presentations were followed by a field trip to the project site to observe the forming of deck joints using UHPC. Benefits of the showcase were directed to facilitating T²: attendees got questions answered about their potential applications of the technology, saw the resources required for such technology to be applied in their contexts, and networked with peers and experts that gave support and built confidence in attendees' ability to also use the technology. Eighty attendees from 14 states participated in the showcase. These attendees represented other state DOTs, transportation authorities, and the construction industry. (Interview with Sandra Larson, Iowa DOT, on July 1, 2013)

- What will be different or what will change as a result of implementing the innovation?
- What can be learned that can be applied to implementation?
- What are crucial elements to success and how can these be identified and transferred?

Confirm decision maker endorsement (refer to Chapter 4 for more details)

- Be sure that upper management is supportive of conducting a demonstration project

Obtain necessary resources (refer to Chapter 7 for more details)

- Funding
- Technical

Communication and logistics

- Identify person or organization that will handle logistics of the demonstration project
- A neutral sponsor could be helpful
- Location
- Personnel
 - Administrative
 - Technical
- Contractors/consultant participation
- Timing
- Travel
- Take-home materials. Participants should have materials with highlights to take away from the demonstration.

Marketing

- Re-confirm audience
- Determine marketing methods
- Create materials
 - Materials should be meaningful enough to attract participant attention and get them to want to attend
 - Should include registration information
 - Should not include too much information to overwhelm a potential participant who may then ignore the opportunity
 - Ensure materials highlight what the participants will get out of attending the demonstration
- Distribute information

Evaluation

- Effectiveness of a demonstration, showcase, or other educational activity could be evaluated in terms of Kirkpatrick’s (1998) criteria for training evaluation. Developed in 1959, Donald Kirkpatrick’s four-level evaluation model is a sequential model for evaluating the effectiveness of a training program. The four levels of Kirkpatrick’s model are reaction, learning, behavior, and results:
 - The first level of evaluation in Kirkpatrick’s model, reaction, focuses on the affective response of participants to a training program. In other words, did participants like the instructor and the content? Most training programs include this level of evaluation.
 - The second level of Kirkpatrick’s model, learning, focuses on the change of knowledge experienced by participants as a benefit of their exposure to a training program. The most common methodology to measure this uses a pre-training exam and a post-training exam, also known as pre-test/post-test. These exams may be conducted corporately or individually. Even if administering a pre-test is not practical, a post-test is useful for measuring the level of participants’ knowledge after the training.
 - The third level of evaluation, behavior (called “transfer” in some documents), is more difficult to assess, but may be the most useful level of evaluation for instructors because it measures the application of new knowledge where participants work. This level of evaluation measures changes in trainees’ behavior as a result of the training event. The responsibility for gathering data about pre-training and post-training behavior often falls to the supervisors of employees.
 - The fourth level of evaluation, results, focuses on changes in business measures as a result of the training. If trainees are able to work more efficiently, lowering costs and raising profits, then the training may be deemed successful from a business perspective. This is the most difficult change to measure; data may be gathered through follow-up surveys or interviews. (Kirkpatrick, 1998)
- Although it enjoys wide use, Kirkpatrick’s model is not the only training evaluation model available. Other models include Stufflebeam’s Context, Input, Process, Product Model (CIPP); Stake’s Responsive Evaluation Model; Stake’s Countenance Model; Kaufman’s Five Levels of Evaluation (modeled after Kirkpatrick’s four-level model); Context, Input, Reaction, Outcome (CIRO); Program Evaluation and Review Technique (PERT); Scriven’s Goal-Free Evaluation Approach; Provus’ Discrepancy Model; and Illuminative Evaluation Model (U.S. Office of Personnel Management, n.d.). These models present differing specific uses or perspectives but most, at their essence, compare knowledge or performance pre- and post-treatment. For most training programs or demonstrations, Kirkpatrick’s model will be useful. However, one of these other models may contain features or qualities that are useful for a specific need.

What Are Some of the Challenges and Barriers to Conducting Effective Demonstrations or Showcases?

Barriers associated with demonstration projects include the following:

- No champion to lead the demonstration effort
- Decision makers not engaged or supportive
- Poor or insufficient marketing to end users
- Innovation not adequately tested
- Benefits of innovation not readily apparent or communicated
- High cost of demonstration efforts (also a resource barrier)
- Insufficient personnel resources to organize logistics
- Insufficient technical resources to answer questions
- Poor or insufficient demonstration opportunities

Note that some of these barriers are similar to challenges that may be encountered when conducting a pilot demonstration project during the research and development phase of the Innovation Adoption Process.

Educate, Inform, and Provide Technical Assistance



1. Have all necessary assistance types been identified?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
2. Have the details of the assistance been determined?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
3. Have the assistance materials been developed?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
4. Is hands-on help required for the assistance?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
5. Has an instructor been identified?
If yes, proceed to the next component.
If no, proceed to component discussion.

Tier 2: Knowledge Building

- Conduct demonstrations/showcases
- *Educate, inform, and provide technical assistance*

Education, information, and technical assistance contribute to effective T² by extending innovative knowledge beyond research and development, and preparing end users for deployment of the new technology. These three actions may also contribute to the Innovation Adoption Process early on by informing decision makers and stakeholders about the advantages of the technology and the benefits of pursuing the technology to address a need. Education, information, and technical assistance may also improve the acceptance of the technology as well as improve communication with the general public.

Education, information, and technical assistance may take any or all of several forms depending upon a particular need. The several forms of education are course development, training delivery, publishing, and conference presentations. Social media and Internet technology (sometimes referred to as Web 2.0) are becoming dominant means for content and information sharing and communication. The several forms of technical assistance are research, remote assistance, and on-site assistance.

Education

Course Development

When a feasible technology is poised for guided T² efforts, the process of educating end users about the benefits of the technology will be important for deployment efforts. Similarly,

educating end users about properly utilizing technology is also essential for effective deployment. One method of education is course development and delivery.

Education begins with the knowledge gathered during the research and development process. Literature reviews, scans, original research, and prototype testing will build a body of knowledge about a given technology. This body of knowledge can then provide the foundation for instructional efforts that follow.

An effective course development process begins with determining the needs of your audience, establishing the goals of your instructional effort, and then finding the best path from audience needs to instructional goals. Supplemental details include whether to include workshops, attendee examinations, and course evaluations and whether the course is to stand alone or be given as part of a curriculum of courses.

Instructional designers and course developers use models for developing their instructional products to ensure the consistency and usefulness of their materials. While many approaches have been developed, a common model is a five-phase model known as ADDIE. The five phases of this model are: analysis, design, development, implementation, and evaluation. These phases guide instructional designers through a process beginning with understanding the problem—identifying a business goal, a performance gap, or, in the case of T², the needs of an audience created by a new technology. After analyzing the need for instructional materials and establishing the goals of the training, designing the course occurs. This phase includes determining the structure of the course, the medium in which it will be delivered, and its content.

The development phase of the ADDIE model is simply the fleshing out of the instructional design. Development may include building a slide presentation, speaker notes, handouts, and evaluation instruments. Presenting a pilot of the new course may also be part of its development. The implementation phase includes all aspects of course operation from marketing through delivery and, as necessary, maintenance with updates. The evaluation phase focuses on the effectiveness of the course, determining whether the instructional materials meet the goals stated during the analysis phase (Carliner, 2003; Instructional Design, 2011).

Course materials typically include a slide presentation, as well as material intended to be handed to attendees during presentations. The use of a slide presentation establishes a foundation of materials to be covered by the training course and consistency if the course is presented more than one time or by more than one instructor. Workshops, if desired, may be developed as part of the presentation materials and provide an opportunity for trainees to test their own hypotheses about the new technology in a supportive environment.

Training Delivery

Traditionally, training is delivered in a classroom situation. Set-up is likely determined by the needs of the organization sponsoring or presenting the training, with some having very sophisticated classrooms including digital light-emitting diode (LED) projectors and smart podiums, while others use less electronic technology.

Electronic technology is enabling new ideas about training delivery including live video conferencing, live web-based presentation (webinar), and recorded web-based presentation. Social networking technology and mobile devices are expanding the possibilities for training delivery even further with the capacity to reach remote and mobile employees.

So, while traditional T² efforts include developing and conducting instructor-led training efforts, self-service learning (e.g., online, self-paced learning [with or without voice-over] and computer-based training), and blended learning (combination of online and face-to-face, instructor-led training) are making headway. Preparing these training efforts for the deployment process can accelerate the effective adoption of an innovation.

Minnesota LTAP Creates Online Course for T²

The Minnesota LTAP Center created a Gravel Road Maintenance and Design **online distance-learning course** in an effort to help local agencies provide training in a more cost-effective manner. The online curriculum is similar to traditional classroom training except that it is much more accessible for students who are unable to travel or prefer a “work at your own pace” environment. Students are free to access the course anytime and anywhere within a 3-month timeframe. This course helps supervisory personnel and operators better understand the materials, techniques, and equipment needed for maintaining gravel roads. It also reviews new techniques and ideas in gravel road maintenance. The course is made up of 10 lessons, each containing a narrated presentation, video clips, reading assignments, a quiz, time to reflect on what has been learned, and time to develop an action plan. (Interview with Jim Grothaus, Minnesota LTAP, on January 13, 2013; online survey response)

There are many existing mechanisms for training development and delivery that may be utilized by an agency engaged in a guided T² effort. For example, the National Highway Institute (NHI) provides transportation-related training in several formats including both instructor-led, classroom-based learning and online learning, including free web-based seminars and asynchronous training materials. If an innovation has been determined to be a feasible solution to a problem, NHI may be of assistance in developing the best educational training method and materials to transfer that innovation to others in the industry. This directly aligns with NHI’s mission goals of training the current and future transportation workforce; transferring knowledge quickly and effectively to and among transportation professionals; and providing training that addresses the full life cycle of the highway transportation system. Similarly, the American Public Works Association (APWA), American Society of Civil Engineers (ASCE), Institute of Transportation Engineers (ITE), and other organizations offer online and computer-based training opportunities that can be utilized for introducing an innovation to a wider audience. The Local and Tribal Technical Assistance Programs (LTAP, TTAP) perform similar functions of effectively transferring transportation maintenance and safety best practices, information, techniques, and processes to the local level. Training and technical assistance for transit can be found through the American Public Transportation Association (APTA) and the Rural Transit Assistance Program (RTAP). Web links to these to these agencies are as follows:

- NHI: <http://www.nhi.fhwa.dot.gov/default.aspx>
- APWA: <http://apwa.net/>
- ASCE: <http://www.asce.org/>
- ITE: <http://www.ite.org/>
- LTAP/TTAP: <http://www.ltap.org/>
- APTA: <http://www.apta.com/Pages/default.aspx>
- RTAP: <http://www.nationalrtap.org/>

Publishing

Disseminating new knowledge may also include some form of publishing. The publishing component of T² education contains several facets, including the following:

- Scholarly articles
- Trade and professional association journal articles

FAA Develops Technical Materials to Enhance T²

The FAA advanced the implementation of Engineered Material Arresting System (EMAS) to improve Runway Safety Areas (RSA) at airports by informing the owners of commercial runways with non-compliant RSAs about the new technology using **several publications:**

- FAA Advisory Circular (AC) dated 9/30/2005
- *ACRP Report 29: Developing Improved Civil Aircraft Arresting Systems*, published by the Transportation Research Board (TRB) in 2009
- FAA Fact Sheet dated 12/23/2011

The FAA ACs provide a single, uniform, agency-wide system that the FAA uses to deliver advisory material to FAA customers, industry, the aviation community, and the public. Having a uniform and consistent source of information is critical for the correct advancement of the technology. These materials are available for viewing on the FAA website, and the major means of distributing final ACs and other guidance is through FAA's AC database. Because there is no legal requirement to publish either the AC itself or a notice that an AC is final in the *Federal Register*, the FAA ensures information distribution by being willing to notify anyone who has registered an interest in the subject matter that the final AC is available in the database.

- Trade and professional association newsletter articles
- Technical briefs
- Manuals and handbooks
- Public agency publications

Scholarly articles and trade and professional association journal articles are typically peer-reviewed papers that meet a very high standard of academic quality. University-based research that leads to implementable conclusions will often meet the criteria for academic quality and be published in a pertinent journal. Trade and professional associations also publish periodicals and newsletters that meet a journalistic level of quality and circulate to a broad readership. These publications are useful for raising awareness about new innovations and their potential uses.

Technical briefs focus on an overview of the technological aspects that will be useful to end users. Manuals and handbooks are often developed to accompany training courses, but may stand alone. These publications are intended for end users and focus on the detailed workings of a process or tool. Public agency publications include state DOT publications, which are manuals or handbooks about DOT-specific processes or tools, but also include federal agency publications, some of which meet standards of academic quality.

Conference Presentations

Professional conference presentations are useful for introducing new ideas and innovations to a likeminded audience. Conferences are typically gatherings of professionals and practitioners in a given field of practice, and these gatherings encourage dialogue between presenters and their audiences.

Information, Content Sharing, and Web 2.0

Web 2.0 is an umbrella term for websites or online applications that are user-driven and emphasize collaboration and user interactivity. Web 2.0 applications used by governmental agencies are sometimes referred to as government 2.0 applications. Web 2.0 applications are also sometimes called social media. Merriam Webster dictionary defines social media as “forms of electronic communication (such as web sites for social networking and micro blogging) through which users create online communities to share information, ideas, personal messages, and other content.” Facebook, Twitter, and YouTube are well known social media channels, but they are not alone in the long list of web-based applications that encourage user interaction.

The National Association of State Chief Information Officers (NASCIO) national survey of social media use in state governments indicates that social media tools are being actively adopted and used throughout state governments across the country. The TRB Committee on Public Involvement found that over half of all state DOTs are using some type of Web 2.0 application (TRB Committee on Public Involvement, 2010, as cited in Volpe, 2010). Similarly, in a recently completed survey of state DOTs, AASHTO found that many state DOTs are specifically using social media tools to reach the public; for example, approximately 81% of survey respondents reported using Twitter for this purpose (AASHTO, 2010).

Regarding guided T² efforts, John A. Volpe National Transportation Systems Center (Volpe) published a report titled *Current Uses of Web 2.0 Applications in Transportation: Case Studies of Select State Departments of Transportation* that indicated that state DOTs are using a wide variety of 2.0 tools to accomplish numerous goals, including to provide information to new and broader audiences, streamline internal communication and efficiencies, build communities of interest around transportation, and support collaborative content creation and problem solving. Agencies generally believed that the use of 2.0 applications provided time and cost savings through more efficient resource allocation and reduced inquiries from the media and stakeholders. Overall, these tools can help agencies more effectively address customers’ needs and further business missions (Volpe, 2010).

Social media can serve as useful education tools to provide timely updates to stakeholders and decision makers, as well as the general public, regarding innovations within DOTs. Wikis—amorphously developed web sites, with little or no specific ownership, which allow anyone to edit content—and shared documents can help with internal knowledge sharing as technical and managerial staff work toward the implementation of an innovation. Social media provides an excellent tool with which to inform the public about projects and engage the public to inform them of new services or innovations proceeding toward deployment.

Key findings of the Volpe report salient to guiding T² include the following:

- State DOTs are employing 2.0 tools to provide information to the public
 - Reach broader audiences
 - Reach new audiences
 - Receive public feedback
 - Respond to the concerns of the public
 - Develop wikis
- Using 2.0 tools is beneficial
 - Fewer inquiries from an informed media and the public can reduce the time committed to managing such inquiries.
- Guidelines for the proper use of 2.0 tools must be developed

While state DOTs now have the tools to share travel information with the public, how and when the public will access and use the information need to be considered. Travel information is most useful during travel, accessed with mobile devices. But this use of technology

raises the issue of distracting drivers from driving. State DOTs using 2.0 technologies to inform the public must develop guidelines for their end users to mitigate the possibility that these beneficial tools could create latent dysfunctions.

In a related topic, *TCRP Synthesis 99: Uses of Social Media in Public Transportation* offered several new ideas based on a survey of transit authorities utilizing social media services (Bregman, 2012). Those related to T² include the following:

- Keep social media in perspective
- Consider the organizational impacts
- Identify the real costs
- Respect the strengths of social media

What Are Some of the Actions That Must Be Considered?

Determine resource requirements

- Staff
- Technical
- Fiscal

Choose the appropriate Web 2.0 tools

- Twitter enables brief messages that are generally informal
- Social media enable comment and response
- Wikis enable in-depth information sharing and are generally more formal (Volpe, 2010)

What Are Some of the Challenges to Managing Social Media and T² Issues?

Additional resources including additional staff

- Web page monitoring and maintenance requires staff availability
- Responding to public comments requires staff availability
- Staff may be needed to develop user policies or to communicate changes in the technology or business practices
- Automated feed systems often require complex set-up and potentially require retrofitting of the previous system
- While mashups, or the combination of several applications functioning together, can require a significant time investment up front, they may reduce costs in the long term (Volpe, 2010)

Performance measures

- Possible ways to quantify the performance of 2.0 sites currently in use are the following:
 - Number of fans
 - Number of followers
 - Number of views

Texas DOT Devotes Staff to Enhance Use of Social Media

The Texas Department of Transportation (TxDOT) estimates that **three employees each devote two hours per week to update its social media sites** and that additional staff are sometimes needed to develop user policies, resolve technical issues, and communicate new developments (Volpe, 2010).

- Number of comments received
- Number of tweets that are re-tweeted (TxDOT, in Volpe, 2010)
- Reduction in calls to emergency call centers (MDOT, in Volpe, 2010)
- Reduction in questions about project schedules (North Carolina DOT, in Volpe, 2010)
- A possible way to qualitatively measure the performance of 2.0 sites currently in use is to measure the frequency with which staffers and members of the public engage in active dialogue using social media (TxDOT, in Volpe, 2010)
- Some measures may be misleading, such as counting followers or fans for sites that may be accessed without becoming a follower or fan (Volpe, 2010)

Security

- Use of social media can increase exposure to cyber threats (Bregman, 2012)

Privacy

- Third-party social media sites may have different privacy policies than the agency using such sites (Bregman, 2012)

Accessibility

- Generally, social media websites rely on graphics, videos, and user-generated content
- Such content is typically unfriendly to persons with certain disabilities (Bregman, 2012)

Records retention

- Generally, social media is not subjected to the same records retention policies as paper files or email
- Records retention policies will likely be developed as state agencies increasingly rely on social media for communication with the public (Bregman, 2012)

Internal access

- Some DOTs do not have clear policies on employee use of social media for professional purposes. Access to tools such as YouTube may be restricted.

What Are Some of the Tools or Strategies Available for Overcoming the Challenges to Managing Education and Technical Transfer Issues?

Link Web 2.0 tools to agency mission

- Develop a clear plan
- Address staff responsibilities
- Consider
 - Target audience
 - Information to be communicated
 - Whether tools accommodate dialogue
 - Whether security and records retention policies are in place (Volpe, 2010)

Consider the value of general applications over proprietary applications

- Many applications are free of charge
- Specific needs may be accommodated by the development of a mashup built upon free applications (Volpe, 2010)

Develop “Use Policies” and address privacy and security concerns

- Determine appropriate use of social media for professional use. These media can be powerful communication and T² tools (i.e., not just for social use), and the development of a policy can outline guidelines for their use

Initiating Social Media Applications at the NYC Metropolitan Transportation Authority

Staff at the Metropolitan Transportation Authority (MTA) in New York took **multiple steps to receive all necessary internal reviews and approvals before moving into social media**. They worked with in-house counsel to review the legal implications, including censorship and privacy issues.

Although MTA does not have a written social media policy, the agency has developed certain agency practices concerning records retention. MTA retains electronic and paper copies of social media posts and staff members summarize social media activities for senior management in monthly reports. Personnel use readily available statistics to track social media activity, to assess the impact of changes, and to identify successful practices. (Bregman, 2012)

- Social media “Use Policies” should be written and available to all employees
- Determine agency personnel that should or may post information for public consumption
- Set rules for participation
 - Consider the rules for public responses
 - Consider rules for drivers accessing the information

Advertise Web 2.0 sites

- Paid advertisement
 - Television
 - Radio
 - Billboards
 - Gas pump toppers (an MDOT consideration) (Volpe, 2010)
- Free publicity
 - Local newspapers
 - Word of mouth
 - Social media
 - Staff email signatures

Evaluate the effectiveness

- Establish a test period
- Develop an evaluation protocol

All Social Media Applications Get a 1-Year Test Period at the Rhode Island DOT

The Rhode Island Department of Transportation (RIDOT) requires a **preliminary, 1-year test period for all new Web 2.0 applications**, thus establishing an agency standard protocol for managing future technological advances. RIDOT believed that this 1-year period would allow it sufficient time to test the effectiveness of tools while ensuring the ability of different applications to achieve agency goals. (Volpe, 2010).

Technical Assistance

Technical assistance is a service whereby engineers or other technical experts are available to a client's customers for advice on pertinent issues within the offered scope. For T² activities, technical assistance would be provided regarding the new technology being introduced. For example, within LTAPs and TTAPs, the customers (e.g., local governments or tribal agencies) may contact an engineer for advice on transportation maintenance and safety issues such as correct traffic sign placement guidelines or how to calibrate the chemical spreader on a dump truck for winter maintenance. There are three primary levels of technical assistance:

- Research
- Telephone/email
- On-site

Technical assistance is most useful to end users for implementing new innovations.

What Actions Should Be Considered?

Assess the need for education and technical assistance in T²

- Do decision makers and/or stakeholders require education about a new innovation?
- Does intellectual property rights counsel need to be educated about a new innovation?
- Can education enhance a demonstration/showcase effort?
- Will education and/or technical assistance be part of the deployment of an innovation?

Connecticut T² (LTAP) Center Offers Technical Assistance Including Equipment Loan Program

In order to help local agencies in Connecticut gather traffic information, comply with different federal requirements (e.g., minimum maintained retro-reflectivity requirements), and improve safety on their roads, the Connecticut T² Center at the University of Connecticut initiated an **equipment loan program** for municipal agencies. The Center has a sign retroreflectometer with a training video that a municipal agency can borrow to help determine actual retroreflectivity levels on their traffic signs. The Center also loans pneumatic traffic monitoring units for gathering traffic volume, speed, and classification data. Not only does the T² Center loan the equipment, but it can help **generate customized reports** on the data collected for the agency. Further, the Center has a Trans Tech Shoulder Wedge Maker to create a safety edge on paving projects. This can minimize the safety concerns of edge drop offs, while at the same time providing a higher density, longer lasting edge on the outside edge of the pavement.

Like most other LTAP/TTAP centers, the Connecticut T² Center offers other forms of **technical assistance** whereby a local agency can contact the center for technical help regarding a highway safety or maintenance technology. In Connecticut, agencies can contact the center for technical assistance using phone, email, or an online request form on their website. (Interview with Donna Shea, Connecticut T² Center, on June 14, 2013)

Cornell Local Roads Program Creates Tool Kit to Help Agencies Comply with Federal Requirements

To assist highway agencies in New York comply with federal minimum maintained retroreflectivity standards, the Cornell Local Roads Program obtained an Accelerating Safety Activities Program (ASAP) grant from FHWA to review the new retroreflectivity requirements and **develop a tool kit for technical assistance** to assist highway agencies with compliance. The funds were utilized to hire a summer intern who interviewed and worked with three counties and towns and villages in the counties to determine which method of sign management would be most applicable. The program then created 50 small sign inspection kits for less than \$50 apiece that were distributed to more than 30 agencies around the state through distribution upon request, or at various statewide meetings. <http://www.clrp.cornell.edu/techassistance/retroreflectivity/TransFilmCompPanels.pdf>

Determine the form(s) of education that will best enhance T²

- Who is the audience for the education effort?
- Is training necessary to educate the audience?
- What type of training will be most effective?
- Is publishing necessary to educate the audience?
- Is technical assistance useful for T²?

Assess the organization's resources for education and technical assistance

- Has the research and development process revealed sufficient knowledge?
- Does the organization employ trainers, writers, or teachers?
- What level of effort is afforded by the organization's budget?
- Is there existing training into which information on this technology can be added?
- Is there an existing training infrastructure available such as a Transportation University?
- Where can a practitioner get assistance delivering training or technical assistance?

What Are Some of the Challenges to Managing Education and Technical Assistance Issues?

Organizational shortcomings

- A weak system/process or lack of a system/process for knowledge management (information not shared readily across the organization)
- Fewer information professionals available within the transportation sector
- Information source is unknown or not credible
- Innovation process is misunderstood or unestablished
- Lack of focus on providing opportunities for exchange and interaction among internal peers and sponsors
- Limited communication between the state DOT and outside organizations
- Loss of competency of staff promoting T² and implementation, including T² and implementation expertise as well as training and technical assistance expertise
- Staff turnover
- Training opportunities are limited and underfunded

Challenges in understanding new knowledge

- Technical staff cannot communicate the importance of the new technology
- Implementers do not understand the technology
- Differences in technical terminologies
- Technical documents not understood by implementers

Challenges presented by the new technology

- Steep learning curve for building expertise in technology
- Complex topics must be mastered
- No technical assistance available from innovation source to facilitate T² and implementation

Process shortcomings

- Information does not get to the right audience
- Technology not presented to the right audience appropriately
- Lack of or insufficient documentation on the technology
- Availability of too much information

What Are Some of the Tools or Strategies Available for Overcoming the Challenges to Managing Education and Technical Assistance Issues?

Training methodologies

- Classroom training
- Train the trainers
- Incorporation of T² skills into academic programs
- Integration of new technology into college curriculum
- Training “academies,” i.e., structured programs for continuous learning
- Certificate programs (e.g., certificate in Advanced Traffic Control Systems)
- Professional organization certification
- Private sector sales and marketing (education on new products)
- T² workshop
- Topic/issue-focused webinar
- Webinars/podcasts/other streaming (possibly live) online instruction
- Self-guided/paced online courses (e.g., online, self-paced learning with or without voice-over, computer-based training)
- Blended learning courses (combination of online and face-to-face, instructor-led training)
- New communication and information technologies and tools used to get the message out
- Social media links focused on knowledge sharing established within the organization

Training purposes

- Internal capacity building for T² expertise (strengthening the skill set)
- Research debriefs with implementers
- Training for procurement/request-for-proposal development
- Training for designers for how to incorporate T² in their designs
- “Just-in-time” training capability for the field
- Training for construction crews in applying new technologies

Publishing methodologies

- New product evaluation reports
- Case studies
- Transition playbook

- Guidebook
- Instruction manual
- CDs/DVDs
- Technical information sheets
- Marketing materials such as product brochures
- Websites

Technical assistance methodologies

- Peer exchanges
- A listserv where users regularly share ideas
- Web portals
- Designated point-of-contact for getting answers
- Coaching and mentoring
- One-on-one technical assistance either by telephone/email or on-site

Other organizational/cultural methodologies

- DOT information technology systems facilitate knowledge sharing and easy access and sharing of ideas
- “Knowledge leaders” champion the growth of expertise in the organization
- Senior management encourages and provides resources for strong internal communication
- “Continuous learning” seen as an organizational value
- Leadership regularly highlights success stories of knowledge sharing within the organization
- Partnerships formed with local universities

Suggested Readings

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Evaluate Progress



1. Has the need been documented?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
2. Has the evaluation coordinator been identified?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
3. Has the feasibility of the solution been identified?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
4. Have the components of the T² process been evaluated?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
5. Has the deployment been evaluated?
If yes, proceed to the next component.
If no, proceed to component discussion.

Tier 3: Evaluation and Decision Making Components

- *Evaluate Progress*
- Reach Deployment Decision

It is axiomatic in organization theory that performance measurement and feedback are essential to improvement (e.g., London, 2003). The importance of evaluation is emphasized throughout the T² literature. For example, evaluating success is a core objective of FHWA's Highways for LIFE program (Bergeron, 2010), evaluating failures is noted as an organizational characteristic for successful diffusion and implementation (Desouza et al., 2009), and outcome measures are regarded as critical for process improvement (Hodges and Wotring, 2012). Just as most T² initiatives are complex, with many intersecting parts, evaluating T² progress can also be a multifaceted endeavor. Considerations in evaluating T² progress are framed in terms of these questions: What should be evaluated? How should the evaluation be conducted? Who should have responsibility for the evaluation process? How should the evaluation information be used?

Considerations for Evaluating Progress

What Should Be Evaluated?

The Innovation Adoption Process serves as a guide to determining what to consider in evaluating T² progress. Evaluation should focus on the components of the guided T² phase of the Innovation Adoption Process, but it is advisable to also include evaluations of related

Innovation Adoption Process phases beginning with the need or problem, research on possible solutions and the choice of a technology to transfer, and deployment actions. Here are some specific points to keep in mind:

Evaluate and document the need

- What is the need? Is it based on a particular problem, deficiency, or opportunity to be pursued?
- How was the need determined, through excessive costs, production problems, customer complaints, or something else?
- Who decided that the need is a priority now, and how was this determined?

Answers to these questions will help to plan and shape the T² effort and the evaluation of any deployment that might follow, so documenting the answers from the outset is important.

Evaluate the feasibility of potential solutions

- What was done to evaluate potential internal solutions, and what were the findings of those evaluations?
- What was done to evaluate potential external solutions, and what were the findings of those evaluations?
- If original research was conducted to develop a solution, did this effort yield a product that could solve the problem? If so, is it a feasible solution for this organization?

If a decision is made to proceed with the T² effort, answers to the questions above will be helpful in several respects, including planning specific T² activities and informing decision makers and stakeholders. Key players should be aware of the steps leading to the T² decision; compelling evaluation data will encourage them to be supportive of that decision. If problems or obstacles are encountered during T², answers to the questions above may help to retrace steps and reevaluate prior decisions. If a decision is made *not* to proceed with the T² effort and the search for a solution continues, documentation of answers to these questions will help avoid duplicating effort.

Evaluate components of the guided T² effort

- Who is the champion? What role is the champion expected to play? Is the champion effective in this role?
- Who is (are) the decision maker(s)? Do they have timely information about the technology? How do they relate to other stakeholders?
- Who are the stakeholders? What are their perspectives on the need and the technology being transferred? What roles do they play in the T² effort? What are their criteria for successful T²?
- Will a cost/benefit analysis be conducted to determine if resources were well spent?
- What communication and education activities will be conducted—demonstrations, show-cases, technical assistance? For what audience(s)? How will the effectiveness of these activities be measured?
- Are intellectual property issues being managed properly?

These are questions that should be revisited periodically throughout the guided T² effort, as negative answers to them could indicate the need to adjust or correct T² activities to keep the initiative on track. Indeed, consideration of these questions should be specified in the T² plan, detailing who should ask them and when, and how the information they yield should be used. To help with this, a checklist is provided in Appendix A to help you track progress through a guided T² effort. You can check off items once they have been identified, defined, and/or addressed. The checklist includes each component most likely to be present in a guided T² effort and can provide a solid foundation for a complete evaluation of the guided T² effort.

Evaluate deployment

- Is there a deployment plan?
- How will deployment be evaluated?

If the outcome of the guided T² effort is a decision to proceed with full-scale deployment of the technology, consideration of the questions above will help to prepare for its evaluation.

How Should the Evaluation Be Conducted?

Evaluation procedures take many forms and serve many purposes. They can be formal or informal, formative or summative, qualitative or quantitative, require original data collection or use existing records. Choices concerning how to evaluate T² should be based on the questions the evaluation is supposed to answer and the decisions it is intended to inform (see the section titled, “What should be evaluated?”).

An organization may have in place many of the measures needed for T² evaluation as part of its performance management and quality control practices. Meeting minutes, memos, email exchanges, and other correspondence document communications among key players (champions, decision makers, stakeholders). Reports and briefings prepared by individuals, working groups, and committees document major and minor decisions made as T² progresses. Of course, evaluation procedures may also require development of measures tailored to the particular requirements of a transfer initiative. If stakeholders constitute a large and diverse group, for example, a survey may be an efficient way to assess their perspectives regarding the problem that’s driving the T² initiative and the feasibility of potential solutions. Effectiveness of a demonstration, showcase, or other educational activity could be evaluated in terms of Kirkpatrick’s (1998) criteria for training evaluation (reactions of participants concerning perceived value of the activity, learning achieved or knowledge transferred, behavioral changes or skills developed through participation, and organizational results or outcomes attributable to the activity).

A formal T² evaluation study may also sometimes be warranted, particularly for large-scale initiatives involving many stakeholders representing multiple units of one or more organizations. The focus of an evaluation study could be on the problem or need that initiated the search for a solution, on the formative aspects of the T² effort, and/or on its summative outcomes—including deployment of the technology. A qualified researcher who is well-versed in program evaluation methodologies should plan and guide a study that includes formulation of the research question, design of the research protocol, selection of measures and oversight of the measurement process, analysis and interpretation of data gathered through the measurement process, and reporting of the findings of the study. The research report should inform champions and decision makers regarding choices such as adjustments that may be needed to foster a successful T² initiative and whether to proceed with deployment of the technology.

Who Should Have Responsibility for the Evaluation Process?

The T² plan should address all aspects of the evaluation process to keep it coordinated and efficient and to ensure that the information it yields is credible, relevant, and understood. The plan should assign responsibility for management of the process to someone with broad responsibility for the T² initiative. Often this will be the champion, but it could be anyone with the requisite authority and performance management skills. In particular, this person must see to it that the relevant parties have the evaluation information they need at the right time to keep the T² effort on track for ultimate success.

How Should the Evaluation Information Be Used?

Information yielded by evaluation of the T² effort serves multiple purposes, including tracking progress toward goals, indicating where and when adjustments are needed, acknowledging and reinforcing contributions of participants, informing decision makers, documenting and communicating successes, and determining when the transfer process is complete and the deployment process can begin. The T² plan should anticipate decision makers' and stakeholders' uses for evaluation information and map the information required to serve the purposes of each.

However “objective” an evaluation may be, it is always open to interpretation. The interpretations of decision makers and stakeholders will be colored by their individual perspectives on the need, the technology being transferred, and the organizational implications if the technology were to be fully deployed. This is both a reality and strength of process evaluation, not a shortcoming or limitation. If the benefits of the technology are to be realized, they must be recognized and valued by all stakeholders. The champion (or other guided T² effort manager) should provide stakeholders with timely information and help them reach a common understanding of it. Careful attention to collection, distribution, and interpretation of evaluation information helps an organization become more proficient at T² and reinforces its innovative culture.

Infosys Develops Metrics to Evaluate Innovation Progress and Enhance Development

Developing appropriate metrics is important in enhancing innovation and, by proxy, successful T². Unique metrics must often be developed when novel approaches or technologies are being utilized or developed. For example, Infosys began as a small software company, experiencing early success providing software solutions to organizations. Leaders at Infosys, however, saw even greater opportunity in providing solutions outside of software. The organization took a significant risk and developed Infosys Consulting, a much broader approach to helping organizations solve their problems, but also a much more complicated one. The result was a tremendous leap in revenue, awards for innovation, and recognition as a known innovator in the industry. **A keystone to their success in innovation was developing unique metrics and scorecards for their new approach to consulting.** Rather than applying the metrics used in the original business, leaders sought to develop adaptive metrics aimed at assessing trends and providing useful feedback to managers. Decision makers realized that to be innovative, novel and unique metrics were a necessary part of the development process. They were wise in their decision to NOT apply commonly used metrics from their original software business. In addition, leaders were willing to adapt and adjust evaluation methods as new information was gathered about the new consulting business. Original concepts and approaches are often in a state of near constant revision—metrics were fluid enough to move with changes, yet explicit enough to provide the information necessary to make additional requisite adjustments (Govindarajan and Trimble, 2010).

Suggested Readings

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CHAPTER 11

Reach Deployment Decision

**Tier 3: Evaluation
and Decision Making
Components**

- Evaluate Progress
- *Reach Deployment Decision*



1. Have evaluations been completed?
If yes, proceed to the next question.
If no or unsure, proceed to the Evaluation component discussion.
2. Are all T² components satisfied?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
3. Has an implementation plan been developed?
If yes, proceed to the next question.
If no or unsure, proceed to the component discussion.
4. Proceed with deployment?
If yes, proceed to deployment.
If no, document reason for not deploying.

Research and/or technology programs having T², implementation, and deployment as central and identified objectives have worked well in transportation applications. For example, the Office of the Assistant Secretary for Research and Technology (formerly RITA) is charged with advancing the deployment of cross-cutting technologies to improve our nation's transportation system. Other federal initiatives that include T² and deployment as components of plans to enhance highway conditions and operations are the Highways for LIFE program, the Technology Partnerships Program, which is a part of Highways for LIFE, and the U.S. Domestic Scan Program. These programs enhance technology deployment, accelerate innovation, and give transportation agency professionals the opportunity to gain firsthand knowledge of best practices and policies and successful technologies that other states have applied.

The tenth and last component of the guided T² phase of the Innovation Adoption Process is reaching a deployment decision. At this point in the guided T² phase of the Innovation Adoption Process, the feasible technology for a particular need has been identified, and many, if not all, of the other components of the guided T² process have been addressed. The champion has likely worked hard to drive the innovation toward deployment. He or she has helped guide the decision-making processes of decision makers and stakeholders, all geared toward moving the innovation toward deployment. At this point, the innovation is known and understood by all relevant parties, and the projected benefits support agency priorities, including its strategic goals.

Decision to Deploy

If at the end of the guided T² effort a decision is made to proceed with full-scale deployment of the technology, a formal way to recognize the decision to move forward is to document it. In addition, the champion, the stakeholders, and the decision makers must be mindful of resources that are required for deployment:

- Technical expertise to support deployment and implementation
- Resources
- Training
- Identification of who and what departments will be involved
- New necessary work processes
- A deployment plan

Managing the process of applying the right tools (of those listed above) to reach the right audience is important to successful implementation.

If a demonstration project was conducted, the lessons learned will help in anticipating the barriers to deployment and working out how they can be avoided or overcome. If other components of the guided T² effort have been well documented, the transition to deployment should be straightforward—the practitioner will not need to “reinvent the wheel.” A deployment plan can be generated quickly using the available resources including relevant pieces of the T² plan.

It is important to have a method for evaluating deployment including performance measures, a delineation of costs/benefits, and documentation of lessons learned and best practices. Documenting successes and failures in the deployment process can ease or even accelerate future innovations because decision makers and stakeholders can see the successes achieved and avoid problems that were encountered.

Lastly, it is important to be prepared, when moving forward, to refine the innovation. Full-scale deployment may identify unanticipated problems, and a champion should be prepared, to the extent possible, to take appropriate steps to remedy the issue.

Decision Not to Deploy

In some cases, during and/or at the end of the guided T² effort, decision makers may decide not to proceed immediately with the deployment. The decision not to deploy may result from several considerations:

- Budgetary shortfalls or other unforeseen changes in resources
- Change in agency priorities or strategic goals
- Turnover of the champion or technical staff
- A different technology satisfied the need
- Appropriate applications are not immediately available

If the decision is not to proceed with deployment, recognize that the problem to be solved—the need—may still be present. The champion and stakeholders should convene to discuss next steps, including moving back to the research and development phase of the Innovation Adoption Process to identify new feasible solutions. These new solutions can be informed by barriers identified in the guided T² effort, including the reasons that the original technology was not deployed.

Considerations for Reaching a Deployment Decision

What Actions Need to Be Considered?

Decide whether the innovation is ready for deployment

- Is the product still feasible?
- Does the product still satisfy the need?
- Have guided T² efforts been successful to date?
- Have guided T² efforts identified any significant barriers to deployment?
- Is a full-scale deployment plan necessary?
- Have resources been identified for full deployment?
- Will education and/or technical assistance be part of the deployment?

If the decision is for full-scale deployment, consider the next steps and whether an implementation plan, including the following elements, will be necessary:

- Resources
- Training
- Technical expertise
- Personnel needed for involvement
- Method for measuring and evaluating deployment

If the decision is made not to deploy, return to an earlier phase in the Innovation Adoption Process.

What Are Some of the Challenges to Making a Deployment Decision?

- Inadequate completion of other steps in the guided T² phase of the Innovation Adoption Process—not enough information to make an informed decision
- Turnover of the champion
- Barriers identified during the guided T² phase not adequately addressed
- Barriers due to
 - Changing priorities that undermine support for innovation in general or for specific technical changes
 - Economic downturn
 - DOT changing priorities or strategic goals
 - Political changes

What Are Some of the Tools or Strategies Available for Overcoming the Challenges to Making the Deployment Decision?

- Complete missing or incomplete components of the guided T² effort
- Identify a new champion
- Continue to engage stakeholders and market the innovation to decision makers
- Review other guided T² components to ensure that they are adequately completed
- Be willing and able to modify or refine the product to overcome barriers



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Glossary

Champion A champion is an individual within an organization who occupies a key linking position; has the right interpersonal skills; and is able to promote, advocate, or represent an idea, concept, or cause as it advances toward wider adoption. A champion helps to overcome indifference or resistance to the new idea and may identify resources necessary for a technology transfer and deployment effort.

Copyright Copyright is a right established in law that permits a person or group to publish, copy, and distribute certain creations of the human mind including literary works, artistic works, and some digitally produced works. This right may be traded or licensed by the holder of the copyright.

Demonstration A demonstration, or demonstration project, is an information exchange mechanism intended to show, explain, or prove the value of an innovation in a context where that innovation is new or unfamiliar. It allows hands-on experiences for participants who interact with knowledgeable peers and others experienced in the technology application. A demonstration is similar to a showcase.

Deployment Deployment of an innovation is the transformation of that innovation from a packaged, limited use to an operational state with broad usage. Deployment may include opening, arranging, installing, testing, or otherwise preparing an innovation for full, intended usage. The result of deployment is that the innovation is ready for implementation.

Feasibility The feasibility of an innovation is the probability that it could logically be implemented based upon criteria such as its suitability, practicality, cost-effectiveness, efficiency, and durability.

Implementation Implementation of an innovation is the complete execution of a plan or process to put that innovation into full effect. The result of implementation is that the innovation is fully employed by end users.

Innovation An innovation is an object, machine, process, or idea that represents a change from established methods of operation. An innovation may be a renewal or an alteration from the established norm, or may represent something new, but is generally a solution that fulfills a need.

Intellectual Property Intellectual property is a creation of the human mind that is new and therefore worthy of protection by law. There are two general categories of intellectual property: industrial and literary/artistic/digital. Industrial property is generally protected by patent law, while literary/artistic/digital property is protected by copyright. Owners of intellectual property may license the use of their property to others.

License A license is a mechanism established in law that gives the owner of intellectual property the ability to allow the use of that property by others.

Need A need is a problem that requires a solution. In the context of this document, a need is a solution that would enable an organization to improve its efficiency, effectiveness, or services to the traveling public.

Patent Patent is a right established in law that permits a person or group to manufacture and distribute industrial creations of the human mind. This right may be traded or licensed by the holder of the copyright.

Product A product is a tangible or discernible article or substance produced to satisfy a want or need.

Research Research is an effort to increase a body of knowledge, or to use the body of knowledge to develop new applications. Research is a creative and systematic effort that may use one or more of several research methods, depending upon the category of knowledge desired.

Resources A resource is a supply of some available means of support to aid the completion of a project. Resources may include people, materials and equipment, facilities, management or personal influence, knowledge, and funding. The term “resources” as used herein designates tangible and intangible assets used to bridge the gap between identification of a feasible product and its deployment.

Showcase A showcase is a setting or occasion in which an idea, process, or object is displayed, exhibited, or otherwise presented to show its best qualities. A showcase is similar to a demonstration.

Stakeholder A stakeholder is a person or group involved in or having an interest in the technology transfer activities of an organization. Stakeholders may be classified as those who are the source of a technology or those who are the recipients of it. The involvement of the stakeholder may include rights, ownership or a share of ownership, or knowledge or understanding of the need for technology.

Technical Assistance Technical assistance is an effort by an expert to offer prescriptive solutions about a specific issue, such as the installation, operation, or maintenance of an idea, process, or industrial object or machine. The assistance may include advice, a demonstration, or training, and may be interactive, in person, or use digital technology or social media.

Technology Transfer (T²) Technology transfer is how ideas, knowledge, practices, products, processes, or techniques are shared between and within organizations. The act of transfer involves at least two parties, a source and a recipient, and is usually purposeful, initiated by the source, the recipient, mutually by both, or by a third party acting as transfer agent.

Trademark Trademark is a right established in law that permits a person or group to publish, copy, and distribute the word, phrase, symbol, or image that differentiates certain industrial property from that of others. This right may be traded or licensed by the holder of the trademark.



APPENDIX A

Guided T² Checklist

Name of Initiative: _____

Guided T²

Checklist

Instructions

Use this checklist to track guided T² progress. With many important components, it can be difficult to remember what has been accomplished or realize what might have been overlooked. Check off items once identified, defined, and addressed. Use spaces to record names and important decisions and accomplishments.

Tier 1: Foundational/Organizational	Address Societal and Legal Issues
	<input type="checkbox"/> Issues understood <input type="checkbox"/> Innovation rights identified <input type="checkbox"/> Innovation rights protected
	Have an Effective Champion
	<input type="checkbox"/> Champion: _____ <input type="checkbox"/> Champion's Role: _____ _____
	Engage Decision Makers
	<input type="checkbox"/> Innovation fully researched and understood <input type="checkbox"/> Primary decision makers: _____ _____ <input type="checkbox"/> Decision makers informed <input type="checkbox"/> Decision makers committed
	Develop a T² Plan
	<input type="checkbox"/> Outcomes defined: _____ _____ <input type="checkbox"/> Plan developer: _____ <input type="checkbox"/> Other parties identified for involvement: _____
	Identify, Inform, and Engage Stakeholders
	<input type="checkbox"/> Source stakeholders: _____ _____ <input type="checkbox"/> Recipient stakeholders: _____ _____ <input type="checkbox"/> Stakeholders understand each others' needs, resources, etc.
Identify and Secure Resources	
<input type="checkbox"/> Innovation fully researched and understood <input type="checkbox"/> Resources defined: _____ _____ <input type="checkbox"/> Resources secured/committed: _____	



APPENDIX B

Suggested Readings on T²

Included in this appendix are suggested readings on technology transfer (T²). These readings were taken from Section IV of a comprehensive literature review of factors related to T² and innovation implementation that was completed as part of NCHRP Project 20-93, Development of a Guide for Transportation Technology Transfer. The selected citations are those that transportation practitioners may find particularly helpful to gain further knowledge and understanding of T². To access the entire literature review, refer to the project website:

<http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3185>

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Elrahman, O.A. Transportation Research Record: Journal of the
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Council, 1999,
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_280.pdf

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Lawrence H. Orcutt, Mohamed Y. Transportation Research Record, No 2109, Research and Education 2009, page 65
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Brenner, D. Holmes, E. Shyu <https://www.ida.org/upload/stpi/pdfs/p-4728nsfinal508compliantfedlabttcreport.pdf>

Technology Transfer Desk Reference: A Comprehensive Guide to Technology Transfer

Federal Laboratory Consortium April 2011,
http://www.federallabs.org/pdf/T2_Desk_Reference.pdf

The Challenge of Innovation Implementation

Klein, Katherine J.; Sorra, Joann Speer The Academy of Management Review, Vol 21(4), Oct 1996, 1055-1080

The Influence of Leadership on Innovation Processes and Activities

Oke, Adegoke; Munshi, Natasha; Organizational Dynamics, Vol 38(1), Jan-Mar 2009, 64-72.
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Rogers, E. M. Science Communication, March 2002, Vol 23, No. 3, pp. 323-341,
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Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI-NA	Airports Council International-North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation