# Transportation Technology Transfer Training and Education Needs

Submitted by:

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# ABSTRACT

Technology transfer is defined as the activity leading to the adoption of a new-to-the-user product or procedure by any user or group of users. Technology transfer is a means to directly affect the rate and nature of innovation and improvements to the transportation system. Whether there is a new device to apply or a more effective manner of performing a task, technology transfer is an essential part of that innovation[1].

The expertise necessary to understand and apply all facets of technology transfer pull and push activities including technical, procurement, institutional, marketing, resource management, training and legal issues is immense. It is difficult for recent hires or professionals new to technology transfer to grasp the fundamentals and be "up and running" in a short period of time.

While the need for trained technology transfer professionals has been expressed in prior research on this topic in specific components of the industry, the authors conducted relevant research and undertook a survey to determine the nature and extent of the need and to gather information useful for the establishment of a Transportation Technology Transfer Certificate Program.

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[1] NCHRP Synthesis 355: Transportation Technology Transfer: Successes, Challenges, and Needs. TRB. National Research Council. Washington, D.C.: National Academy Press. 2005.

# INTRODUCTION

Technology Transfer activities help identify solutions to critical problems, leverage scarce resources, avoid duplicative research efforts, identify potential operational problems of new technologies and ensure dissemination and implementation of useful research products[2]. The efforts of T2 specialists initiate T2 and facilitate the process, including implementation of the research product when appropriate.

Transportation agencies understand the importance of technology transfer and have sought to develop technology transfer expertise within their workforce[3]. Federal agencies and organizations such as FHWA, TRB, and AASHTO have been engaging in research, training, and technology transfer activities and assisting states in developing today's experienced technology transfer professionals in transportation agencies.

However, the transportation technology transfer community is expecting several impending challenges in the near future:

First, many of our technology transfer professionals have spent years acquiring their technology transfer related knowledge base. However, these same employees are part of an aging workforce, and a wave of impending retirements at transportation agencies threatens to dramatically reduce the technology transfer experience base.[4]

Second, there is no formal educational curriculum for transportation technology transfer. To date, there has been no general curriculum available that can be used for teaching technology transfer in universities or adult and professional education programs available to agency workforce.[5]

The lack of such a curriculum poses several difficulties. First, technology transfer professionals must develop their expertise in an ad hoc fashion often combining years of experience, continuing education, and self-study. This approach does not bode well for quick replacement of technology transfer expertise lost to retirement or other job

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[2] Special Report 256. Managing Technology Transfer: A Strategy for the Federal Highway Administration. TRB. National Research Council. Washington, D.C.: National Academy Press. 1999.

[3] Nakanishi, Yuko, Sam Elrahman and George F. List, Evaluating Technology Transfer Programs, Rensselaer Polytechnic Institute Working Paper, 2000.

[4] *Human Capital Report: Revised Human Capital Plan and Dossier of Accomplishments*. U.S. Department of Transportation, September 2004.

[5] A quick scan of universities revealed a lack of broad-based multidisciplinary T2 educational offering at the undergraduate and graduate level. The few universities that offered graduate programs were typically "single course" and did not represent the depth and breadth of coverage needed for educating T2 professionals.

opportunities. This approach also provides no assurance that all technology transfer competencies are achieved or even identified.

To achieve the next level of success in technology transfer, we must educate and train a broader section of the transportation workforce in the fundamentals of technology transfer. Such education/training, especially pre-career or early career, would strengthen the technology transfer culture in most transportation related organizations. To achieve these goals we need a general educational curriculum for technology transfer.

The authors, in discussions with members of the FHWA and State DOTs, confirmed the need to explore the development of a Transportation T2 Specialist Certificate Program. To assist in the determination of the nature of the need and possible program content, the authors undertook a survey of relevant members of the transportation community including State DOTs, LTAP centers, and University Transportation Centers.

In this paper, the authors address the potential benefits of a Transportation T2 Specialist Certificate Program, and the results of the T2 training and education needs survey.

## POTENTIAL BENEFITS

T2 encourages the transfer of technology and its implementation. Agencies expend millions of dollars every year for research. If implementation does not occur, the monies will have been wasted. The more a technology or research product is implemented and used, the greater its benefit/cost ratio will be.

T2 specialists who have successfully completed a T2 certificate program charged with T2 activities will fulfill their responsibilities more efficiently and effectively. They will also spread their newly-gained T2 knowledge and expertise throughout the agency.

Furthermore, the benefits will be cumulative -- graduates of the T2 certificate program encounter more and greater responsibilities in technology and information sharing as they advance in their career. They will also have opportunities to share the knowledge and expertise that they have gained through the program and help other colleagues progress in their T2 skills and expertise. This can translate into significant benefits for practitioners, users, and sponsors.

The stakeholders and beneficiaries of T2 certificate programs include research sponsors (agencies, industry), users (agencies, industry), practitioners (agencies, industry), and students. By educating the researchers of an agency, the entire agency benefits through the promotion of T2 within the agency and among agencies. The staff member who has completed a T2 certificate program may facilitate an information sharing program among agencies performing similar research efforts and in doing this, the staff member may become aware of a technology or some other solution to a costly problem that the agency had been experiencing; or, the staff member may be alerted by another agency to a

potential operational problem caused by a new technology that would have cost the agency millions of dollars had it not been identified.

## SURVEY RESULTS

Despite the gains that have been made in the Transportation Technology Transfer field over the last several decades and despite the very successful efforts to foster a technology transfer culture, the survey results indicated that more effort is needed with regard to education and training. A comprehensive understanding of technology transfer requires understanding of a wide variety of disciplines. The issues of relevance highlighted in each of the key program areas by the survey respondents suggested potential program content. The survey results also generated ways in which possible T2 Specialist Certificate Program may be designed and delivered in order to meet the specific needs of transportation staff at State DOTs and LTAP centers.

This section provides the details of the survey results.

### Respondents

Of the 50 State DOTs that were surveyed, 20% have responded. Of the approximately 50 LTAP centers that were surveyed, 20% have also responded. It is interesting to note that of the 30 university centers surveyed, none have responded with the exception of the sponsoring center. Geographically, all four regions were represented with the following percentages:

**Figure 1 – Geographic Distribution of Respondents**
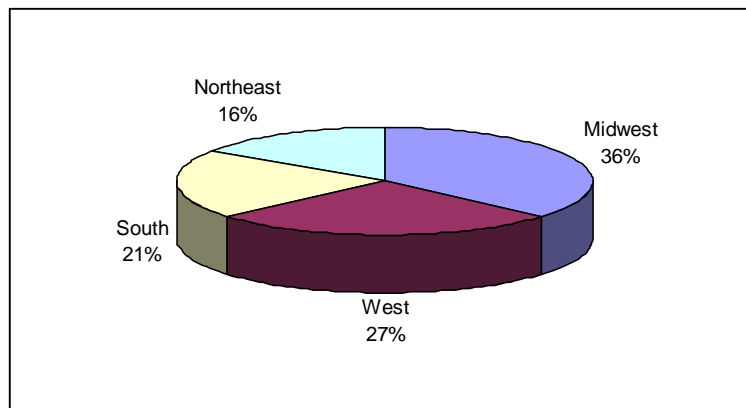


There was no indication that geography affected or was correlated with the responses to the questions.

Of the State DOT respondents, all had minimal T2 staff, 15 or fewer. Two respondents indicated much larger staffing, one with 31-50 T2 staff and the other with 51-75

personnel. In terms of the nature of T2 activities, 6 State DOTs indicated that they were a combination of all characteristics - a developer of technologies, a recipient of technologies, and training or education focused. The other 4 indicated that they were primarily a recipient of transferred technologies.

Of the LTAP respondents, practically all of the LTAP centers have a small T2 staff, of no more than 15 members. One of the centers, though, stated that it had 76-100 personnel that practiced T2. 80% of the centers were training or education focused to facilitate the effective use of technologies. One center indicated that they were a combination of all characteristics – a developer of technologies, a recipient of technologies, and training or education focused. Another center indicated that they were a developer of technologies and training or education focused to facilitate their effective use.

**Benefits**

The respondents were asked to rate the statements pertaining to benefits of a T2 Specialist Certificate Program according to a five-point likert scale, with each point indicating the accuracy of description of their beliefs:

> 1 = Poor; 2 = Slight; 3 = Good; 4 = Very Good; and 5 = Excellent

The first statement was regarding the respondent's personal belief regarding the beneficial nature of the program. The average response for the first statement was 3.4. 70% of State DOTs and 70% of LTAP responses were at least a 3, indicating their belief that the development of a Certificate Program would be personally beneficial to them.

The second statement addressed their organization's view about the program and whether they would encourage staff to enroll. For State DOTs, the average response was 2.8 and only 40% of State DOTs indicated a response between 3 and 5. Because the percentage of State DOT respondents indicating that the program would be beneficial was higher, this indicates that State DOTs may not be prone to promote a T2 training program to their personnel although they may acknowledge the benefits of such a program. These results may suggest the need for clear delineation and presentation of the program benefits to state DOT management. A larger percentage of LTAP centers, 60%, indicated a response of 3 or higher.

The third statement dealt with the possibility of their organization offering reimbursement of tuition and other expenses. 70% of State DOTs and 60% of LTAP centers responded with a 3 or higher.

**Table 1 (a) – Benefits, State DOT Results**

|  | BENEFITS | | |
| --- | --- | --- | --- |
|  | **1** | **2** | **3** |
| **Average** | 3.4 | 2.8 | 3 |
| **% > 3** | 70% | 40% | 70% |

**Table 1 (b) – Benefits, LTAP Results**

|  | BENEFITS | | |
| --- | --- | --- | --- |
|  | **1** | **2** | **3** |
| **Average** | 3.3 | 3.4 | 3.2 |
| **% > 3** | 70% | 60% | 60% |

**Expected Participants**

Knowing who the potential participants of a T2 Specialist Certificate Program will be is essential in terms of Program development and implementation. State DOTs indicated that the expected participants were primarily researchers and central office project or program management staff followed by field office project or program management. While LTAP respondents also indicated that the expected participants are central office project or program management staff, the other primary category of expected participants was new hires. The percentage of LTAP respondents that selected the category of researchers was much lower – 20% for LTAP respondents vs. 50% for State DOT respondents. At the same time, the percentage of State DOT respondents that selected the category of new hires was 10% vs. 70% for LTAP respondents.

Both State DOT and LTAP respondents indicated that college-level students were not expected participants of a T2 certificate program. Only 10% of LTAP respondents and 0% of State DOT respondents chose the category of students as expected participants. This result suggests that "mixing" college-level students and transportation professionals is not an expected or desirable scenario. This may be due to the distinct difference in objectives, perspective, and experience between students and all of the other categories of expected participants, with the possible exception of new hires.
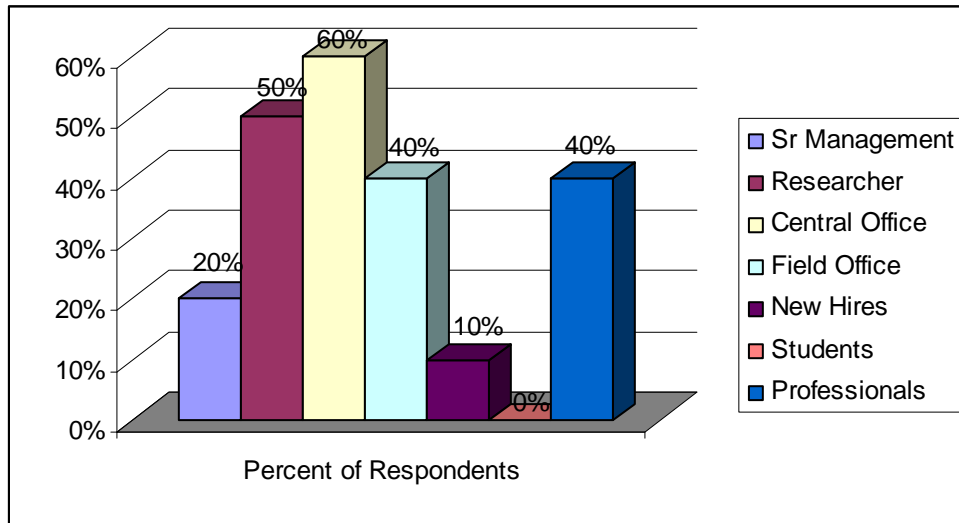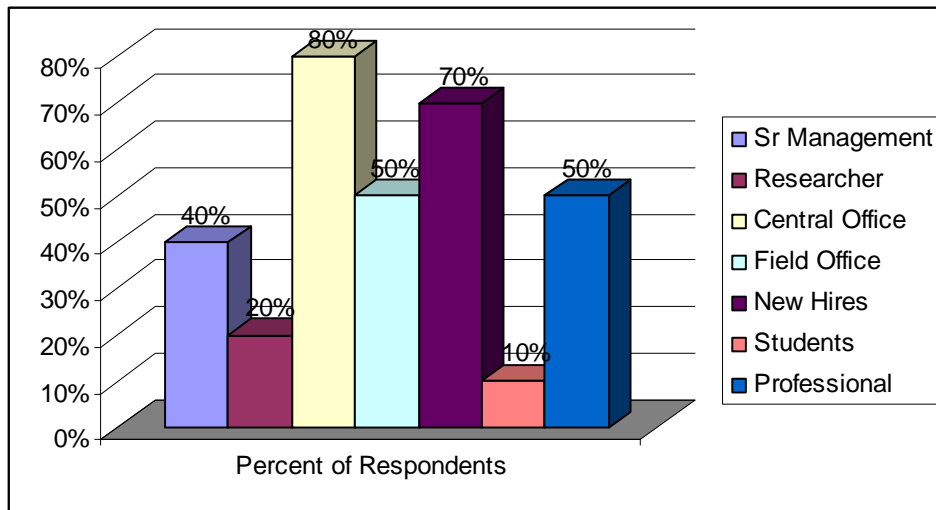
**Figure 2(a) – Expected Participants, State DOTs**



**Figure 2(b) – Expected Participants, LTAP**



**Challenges**

The greatest expected challenge faced by both State DOTs and LTAP centers in sending staff to a T2 specialist certificate program was time constraints, followed by funding constraints. A greater percentage of LTAP respondents believed the funding constraints for tuition would be a challenge -- 70% of LTAP vs. 50% of State DOT respondents. In the "other" category, funds for travel and per diem expenses were also believed to be an expected challenge. One State DOT respondent mentioned that "justification", most likely to senior management, would be an expected challenge as well.

**Program Content**

In terms of program content, all of the topics mentioned in the key proposed categories were believed by at least a percentage of respondents to be of interest for inclusion within a T2 specialist certificate program. Therefore, the topics that were indicated by 50% or more of the respondents will be described in this section.

### *Content – Technical*

The following technical issues were included in the survey:
- Technology evaluation methods (including testing and analysis)
- Standard setting
- Countermeasures for weak research outcomes

The Technical area does primarily apply to the user of the new technology; however, some of the subtopics in this area also apply to technology providers. It is important for users to employ appropriate evaluation methods to determine whether the technology is actually applicable within their operational environment and can address their needs in a cost-effective manner. At the same time, technology providers should communicate information about relevant testing and analysis techniques to prospective users.

In terms of standard setting, performance standards need to be set by both the users and providers of the technology. The providers should ensure that the developed technology meets certain minimum standards and strive to maximize the quality and effectiveness of the technology. The T2 specialist needs to know the demands of the organization and the performance standards a technology must meet in order to meet those demands.

In terms of weak outcomes, this subtopic applies to technology users in situations in which evaluation results show that the technology is partially suitable to their needs – and to technology providers who were not able to produce a technology which met expected performance standards – whether they should continue to expend resources to improve upon the technology and how they can improve upon the technology to make it more useful are addressed under this subtopic.

Most State DOT and LTAP respondents believed that technology evaluation methods should be included in the program. 60% of State DOT respondents believed that countermeasures for weak research outcomes should be included and 60% of LTAP respondents believed that standard setting should be included.

*Content – Procurement*

The following procurement subtopics were included in the survey:
- Design of specifications
- Disclosure issues
- Costs / prices
- Licensing issues
- Transfer terms

Technology procurement requires a great deal of foresight and knowledge about specific procurement issues such as design of specifications and transfer terms to ensure that the contractor delivers technology that is suitable and affordable. Proprietary technologies will raise licensing and disclosure issues that need to be addressed. Also, evaluating costs and prices is not a simple task – unit costs, O&M costs, and life cycle costs need to be considered.

For State DOTs, licensing issues followed by disclosure and cost/pricing issues were the topics that most respondents stated should be included in the curriculum. 70% of LTAP respondents selected cost/pricing and licensing issues. 50% of State DOT and LTAP respondents thought design of specifications should be included.

*Content – Institutional*

The following issues were included in the survey:
- Change management (including risk-aversion issues)
- Organizational structure and its impact on the success of T2
- Political issues

The institutional area relates to how T2 functions within the organization and the impact of organizational structure on the success of T2 efforts including the placement of T2 specialists within the organization. Institutions often face change management challenges such as risk aversion. Political issues such as the acceptance of T2 as a staff function by line operations personnel also create obstacles that need to be addressed.

90% of LTAP respondents and 70% of State DOTs believed that organizational structure and its impact on the success of T2 was an important topic. 70% of State DOT and 60% of LTAP respondents stated that change management should be included. 60% of LTAP respondents vs. 40% of State DOTs indicated political issues for inclusion. An LTAP respondent recommended the discussion of the various institutional issues connected with an LTAP being housed within a State DOT.

*Content – Marketing*

The following marketing subtopics were included in the survey:
- Identification of needs looking for solutions
- Identification of solutions looking for needs
- Strategies and techniques
- Marketing campaigns (conventional and web-based)

Marketing applies to both users and providers of technologies. The users seek to identify solutions for the needs of their agencies and the providers seek agencies that require their technologies—in some cases, marketing campaigns may be helpful. In both situations, relevant strategies and techniques should be known and practiced by T2 specialists.

According to the respondents, all of the marketing issues should be included in the program. 70% of State DOTs and 100% of LTAP centers selected identification of needs looking for solutions and 70% of State DOTs and 80% of LTAP centers selected marketing strategies and techniques. A State DOT respondent suggested the discussion of marketing benefits, and an LTAP respondent suggested vendor partnering in the creation of a marketing strategy.

*Content – Resource Management*

The following issues were included in the survey:
- Workload distribution
- Time management
- Resource allocation (prioritization of T2 projects, activities)
- Evaluation techniques of T2 outcomes
- Skills assessment of T2/research staff

Proper resource management will ensure that the allotted budget for a T2 program or activity is not exceeded and that the resources are used in an effective manner. Resource management for T2 programs requires excellent resource allocation skills including workload distribution and time management. Knowledge of relevant resource allocation software tools will be important in prioritizing T2 projects and activities. In addition, an essential component of resource management is skills assessment of T2 and research staff which will assist in the assignment of the most suitable staff to a specific T2 project or activity and determine gaps in required expertise.

Evaluation of T2 outcomes will provide lessons learned for future T2 efforts and will determine their success level. Objective and scientifically robust techniques should be used to ensure the validity of the evaluation results.

For LTAP respondents, all issues listed in the survey were important, with time management receiving the most "votes". In addition, an LTAP respondent recommended the inclusion of relevant project and resource management software that can track cost, time, HR and other resources expended on specific T2 projects. For State DOT respondents, resource allocation and evaluation techniques of T2 outcomes were of most concern followed by workload distribution.

## *Content – Legal Issues*

The following issues were included in the survey:
- Relevant legislation
- Patent issues
- Copyright issues
- Product liability / insurance issues

Legal issues such as patent, copyright, product liability, and insurance will arise during the technology transfer process. To safeguard agency rights and interests, the T2 specialist must be cognizant of relevant T2 legislation and accepted legal procedures.

LTAP respondents were equally concerned about the legal topics of relevant legislation, copyright issues, product liability / insurance issues followed by patent issues. An LTAP respondent suggested the inclusion of State policies regarding vendor copyright laws. State DOTs were primarily concerned about copyright issues followed by patent issues, relevant legislation and product liability / insurance issues.

## *Content - Training Programs*

The following issues were included in the survey:
- Program development
- Presentation skills
- Conventional / technology based training techniques

Training programs are relevant to providers of the technology and the T2 specialist within the user organization. The providers need to be aware of the available training tools and the optimal techniques for a particular technology. The T2 specialist in the user agency will work with the technology providers and trainers to develop a suitable training program and mix of delivery methods. The T2 specialist will also coordinate with the trainers to ensure they have excellent presentation skills suited for a particular technology and skill level of the audience.

The State DOT responses for the three training program items, program development, presentation skills, and conventional / technology based

training techniques were evenly distributed. One State DOT recommended the coverage of training resources. Since agencies are often impeded in their training activities by fiscal constraints, this recommendation is a very relevant one. LTAP respondents selected program development and presentation skills as a top priority. One LTAP respondent suggested another training-related item – adapting training methods to meet client needs.

**Delivery Preference**

The delivery method impacts the effectiveness of learning and retention that take place. Also, delivery methods affect the costs of the technology transfer process and the speed at which it takes place. Therefore, some methods may be appropriate for certain agencies but not others. Of the following, the respondents were asked to select the two most preferred delivery methods for their agency or organization.

- Traditional classroom
- Interactive classroom (with tabletop exercises and class projects)
- Distance learning (all classes conducted via internet)
- Blended learning (combination of distance learning and classroom)
- Self-paced learning via CD/DVD (no instructors)
- Self-paced learning via internet (no instructors)

The top two delivery preferences for State DOTs and LTAP centers were interactive classroom and blended learning. The two self-paced learning options with no instructors received the least responses from both State DOTs and LTAP centers. In terms of traditional classroom, 18% of LTAP respondents vs. 11% of State DOT respondents selected this method. The conclusion that may be drawn from these results is that the presence of an instructor, either in-person or online, is important and desired.

## CONCLUSION

A Transportation T2 Specialist Certificate Program would significantly expand the supply pool and standardize and consolidate the training and delivery mechanism. The survey results indicated that there is indeed a need for a Certificate Program for Transportation Technology Transfer Specialists and suggested ways in which such a Program could be designed and delivered.

The challenges of marketing a T2 Certificate Program to transportation agency management are similar to the challenges in marketing any type of training and education program. Investment in the Program by the agency – tuition, time-off, and other incentives or expenses such as travel -- must be offset by the perceived benefits of the Program. Because the agency decision makers need to be convinced that these benefits outweigh the costs, Program benefits should be clearly delineated and articulated by the provider to the agency.

## ACKNOWLEDGEMENTS