Workforce Development Needs and Objectives of Today's Transportation Engineering Professional

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Workforce Development Needs and Objectives of Today's Transportation Engineering Professional: A Regional Case Study

Abstract

Given the growing influence of technology and innovation, the skillset and knowledge required of today's transportation engineering professional includes many different subject areas. For this reason, transportation engineers and managers alike must constantly seek out workforce development opportunities to expand either their learning or the skill set of their employees. This study examined transportation education needs on two fronts. First, an assessment was initiated identifying available course training offerings and their curriculum and delivery characteristics. Second, an investigation into training needs was conducted using a mixed-method approach consisting of personal interviews and an online survey. This study concluded that while training is a highly personal decision and influenced by many different factors, those related to cost, location, and topic area ultimately drive an individual or agency to pursue such opportunities. These findings can inform both practitioners and researchers to strategically determine how future training opportunities should be developed and shaped to meet the growing demands of tomorrow's transportation engineer.

Introduction

Employee training supports the knowledge base of an individual or a collective agency and ensures that staff are equipped with the information needed to complete a project or activity. As updates in technology, standards, and policy drive changes in engineering practice, it becomes vital that employees have access to timely and meaningful training opportunities. This training, which categorically falls under the broad umbrella of workforce development or continuing education, includes topics that range from discipline-specific content to those focusing on organizational dynamics, and can be presented in a wide variety of formats such as in-person presentations, hardcopy materials for self-study, or as online short courses and seminars. These training opportunities are an important part of both organizational and individual success. As transportation engineering policy and practice evolve, resources will be needed to anticipate and address challenges before they arise and prepare a workforce that can adapt to changes as they occur.

The purpose of this research was to gain insight into existing training needs and identify potential gaps in professional development within the transportation engineering domain. To address this purpose, an exploratory, mixed method project was designed and developed. In the first phase, a qualitative, structured interview protocol was created and interviews were conducted with transportation engineers, managers, and learning coordinators. These findings informed the second phase, which entailed developing an online survey tool for broader distribution. The survey was then sent to engineers and managers across the Pacific Northwest.

Literature Review

Training decisions are often made based on a complex set of personal and organizational factors. As individuals complete day-to-day tasks and manage their assignments it is critical that their

knowledge and skills are current. But the challenge of identifying and understanding new information and requirements can be significant. Employees must first figure out what they need to learn to solve a problem and then learn it. At the same time, larger organizations recognize that the provision of training comes with balancing training needs with each agency's priorities. Just because a training opportunity exists does not mean it will benefit the relevant stakeholders. For example, when and how frequently should an employee be entitled to training opportunities? How does the agency recover its investment? What are the agency's philosophies and overall budget allocation with regard to training? What are the philosophies of individual managers and supervisors [1]? A range of criteria must be considered regarding the decision to participate in training or professional development.

For civil (and transportation) engineers, there is added recognition that "civil engineers must learn and apply new technologies that (may not have been) included in a traditional (academic) curriculum [2]. Such issues become amplified as the design of intelligent transportation systems and the evolution of connected vehicle systems grows increasingly interdisciplinary. The lack of workforce development "supporting improved systems operational management is becoming a more serious constraint to improving mobility … and the demand of new technologies on staff capabilities has also been recognized in ongoing professional capacity building efforts at the United States Department of Transportation and in some university curricula [3]." Training approaches in transportation engineering need to improve in ways that appreciate the role of technology and that provide more relevant educational experiences.

As recently as March 2017, the American Society of Civil Engineers' Board of Direction (ASCE) adopted a new policy statement suggesting that student learning at the college level should be expanded. "ASCE supports the attainment of the Civil Engineering Body of Knowledge for entry into the practice of civil engineering at the professional level (i.e., practicing professional engineer) through appropriate engineering education and experience, and validation by passing the licensure examinations … and encourages institutions of higher education, governments, employers, engineers, and other appropriate organizations to endorse, support, promote, and implement the attainment of an appropriate engineering body of knowledge for individual engineers [4]."

One year earlier, the Transportation Education Council of the Institute of Transportation Engineers undertook a complementary effort to identify employers' opinions on expectations and desires for a transportation engineering degree program. This effort involved conducting an initial assessment identifying key characteristics that employers are looking for in new graduates entering the transportation engineering field, with "willingness to learn" identified as the highest-ranked item [5]. People skills, writing skills, and general analytical skills were also listed as important characteristics. When queried on exposure to technical subject matter taught at universities, practitioners highlighted two topics: familiarity with the MUTCD (Manual on Uniform Traffic Control Devices) and intersection capacity and level of service analysis. Other topics rated as medium to high importance included, but were not limited to: familiarity with the HCM (Highway Capacity Manual), pedestrians and bicycles (complete streets), traffic signal phasing and timing, and horizontal and vertical roadway design [5].

These examples highlight the importance of making certain that young professionals are exposed, both in breadth and depth, to essential technical competencies and, when appropriate, additional learning in the form of workforce development training or continuing education. It is

also important to note that workforce development consists of not only increased knowledge but also the role of mentorship and other professional-related opportunities [6].

In terms of delivery methods, there is a variety of available formats, and technological advances have created additional opportunities to "bring" the training to the employee. In Table 1, a list of common methods is shown. Each method offers its own advantages and disadvantages, and generally will be influenced by costs associated with travel or staff time, the timeliness of the information provided, the expertise provided by the individual or individuals leading the training, and the resulting learning format which may or may not be conducive to a particular individual [1].

TABLE 1 Advantages and Disadvantages of Specific Methods

Method	Advantages	Disadvantages
Presentations (live and virtual)	Opportunity for interaction and discussion; affords participants the flexibility to ask questions and clarify understanding	Presenters must be able to effectively communicate and provide useful information; requires travel by participants (live presentations)
(Hands-on) Training	Opportunity for interaction; allows participants to ask questions; opportunity for attendees to learn; environment creates knowledgeable staff and workforce	Schedule conflicts; can be difficult to establish balanced training across all staff members; details much match need; can be expensive
Webinars	Reduces or eliminates travel time; can reach a larger audience; recorded or archived presentations can be reviewed; duration can be flexible	Lack of interaction between presenter and audience; typically requires an internet connection and software application; difficult to implement hands-on activities
Videos	Can be viewed at the discretion of the user; content to be accessed by a large audience (i.e., YouTube); more lively than written documents	May not necessarily be relatable to user; content and perspectives can become outdated over time; production costs could be significant
Handbooks	Comprehensive; can be used as a reference guide; contains useful information provided in a detailed manner	Printing costs (for hardcopies); may not be used regularly; exhaustive to read; bulk can be intimidating
Decision-Support Tools	Provides information that is conducive to making an informed decision; allows users to apply knowledge developed from past experiences at a broad level	May require extensive use of technology and learning; reliance on good data can be restrictive; larger systems can be cost-prohibitive
Community of Practice Support	Participants share common interest; team-oriented environment; multiple opportunities for networking and interaction	Participants may lack the necessary skills and background; organizations must develop a clear understanding of how knowledge will be applied in practice

It should be noted that program development and the long-term commitment to online programs are often expensive and cost-prohibitive despite their increasing popularity [7]. For example, the Global Road Safety course at the University of Iowa had found success as an in-person, academic credit-based course. When consideration was given to developing an online interactive version open to parties outside of the university, cost (associated with registration and the registration process itself) and scheduling challenges grounded the effort. For these reasons, a

short-course format was ultimately "found to be much more successful in attracting participants [8]." A separate study noted that "some of the most important considerations of successful online training programs (for staff at a state department of transportation) are: (a) the inclusion of interactive components within the training modules to keep participants engaged, (b) a short duration for each of the training modules to retain participants' attentiveness, and (c) the provision of quizzes to assess participants' understanding of the material [9]." This study further acknowledged that an effective online training program can "develop the skillset of personnel both efficiently and effectively, and help facilitate capacity building of transportation professionals". A majority of the DOTs who were interviewed acknowledged that online training was required of their employees, suggesting that DOTs were "making online training programs as a part of their capability building efforts [9]." Such research points to important criteria to consider when designing new training efforts.

To address workforce development needs in transportation-related topics, the Federal Highway Administration, in partnership with the United States Departments of Labor and Education, has established five regional transportation workforce centers to enhance transportation workforce development more strategically and efficiently. Establishment of these centers represents one of the first concerted efforts to consolidate and prioritize the need for such training opportunities. These centers are designed to "create, coordinate, and facilitate partnerships with State departments of transportation and education, industry, and other public and private stakeholders to enhance transportation workforce development throughout the education continuum." Further, these centers "facilitate middle school and high school activities, training in technical schools and community colleges, universities, and post-graduate programs, and professional development services for incumbent transportation workers [10]." As an example, the Pacific Northwest of the United States is served by the West Region Surface Transportation Workforce Center (WRTWC) at the Western Transportation Institute at Montana State University in partnership with the Upper Great Plains Transportation Institute. The WRTWC actively broadcasts training opportunities on its website and by e-mail and encourages new partners to join its stakeholder network.

The WRTWC is not alone in offering training. In fact, within the transportation (safety) domain, there are a plethora of entities who currently offer training on a wide range of topics. Federal agencies, state-level agencies, associations and non-profits, university-affiliated centers and programs, and other entities all participate at varying levels, and the bulleted list below, though not exhaustive, suggests that workforce development and continuing education opportunities are widely available to interested consumers:

- Federal Agencies - National Operations Center for Excellence, National Center for Rural Road Safety, National Transportation Safety Board Training Center, Transportation Safety Institute: United States Department of Transportation, National Highway Institute, Federal Motor Carrier Safety Administration, Intelligent Transportation Systems: United States Department of Transportation
- State-Level Agencies - T2 Center, Minnesota DOT, Minnesota LTAP, Technology Transfer Program: University of California Berkeley, Transportation Training Academy
- Associations and Not-for-Profits - American Society of Civil Engineers, Institute of Transportation Engineers, American Traffic Safety Services Association, ITS America, National Safety Council, Commercial Vehicle Safety Alliance, International Road Federation Global, Tribal Safety

- University-Affiliated - University of Maryland, Portland State University, University of Minnesota, Rutgers University, Montana State University
- Other Entities - Lifesavers Conference, 360training.com, National Safety Compliance, OHSA.com Transportation Safety Courses, IMPROV, CED Engineering, Center for Transportation Safety

While there is an abundance of training offerings in transportation engineering and safety, a systematic investigation into the training needs within a large region and how decisions to participate in training are formulated have not been well-documented. For this reason, this study developed a framework that could be implemented by agencies or institutions to provide insights into employee training needs and decisions.

Characteristics of Current Offerings

As noted, a goal of this project was to gain a broader understanding of the kinds of training currently available within transportation engineering domains. To assess the breadth of transportation and traffic safety-related offerings actively available to practitioners and members of the general public, a snapshot of current offerings was developed by conducting an on-line search during the last two weeks of January 2018. Course offerings were aggregated by topic, host organization, format, length, and cost, based on available information. Over 140 different training opportunities were identified, and common characteristics included, but were not limited to, the following:
- Topics – within transportation safety, key words included: access management, automated driving, complete streets, road safety audits, vision zero, roadway design, traffic calming, and intelligent transportation systems
- Format – in person, live webinar, podcast, and online video or online course
- Length – webinars typically ranged from 60 to 90 minutes, while in-person courses ranged from half a day to a full day to several days
- Cost – varied significantly; some trainings were free while others established rates based on: individual or group participation, member or non-member (of entity providing training), student or practitioner, and early versus late registration.

Methods

This study investigated training experiences and needs within transportation engineering and safety and consisted of two major phases: 1) interviews with local transportation officers and 2) the development and distribution of an online survey. The overall research design followed a sequential, exploratory mixed-methods approach [11]. During the first phase, qualitative data (i.e, interviews) were collected and analyzed. These findings were then used to inform the development and execution of the second, quantitative phase (i.e., survey development). This research approach is particularly useful in cases where relatively little is known about the topic of interest, and in which initial open-ended perspectives can provide direct insight into subsequent research. Given the purposes of exploring perspectives regarding services that do not yet exist, a sequential, exploratory mixed methods design was well suited for the goals of this study. Qualitative analysis followed approaches consistent with Miles, Huberman, and Saldaña [12] for descriptive coding emergent patterns. Similarly, quantitative analysis was descriptive and conducted based on recommendations from Creswell [11] for exploratory research. Survey

and data collection were reviewed and approved by the Institutional Review Board of Oregon State University (IRB #8382).

Phase 1: Structured Telephone Interviews
During the first phase of the research, structured qualitative interviews were conducted with transportation engineering managers, practitioners, and learning coordinators across four states in the western region of the United States. This sample population was selected because they represented both the individuals attending the training and stakeholders who made decisions regarding training. Participants were recruited through personal contacts from researchers at Oregon State University (OSU), University of Idaho (UI), Washington State University (WSU), and University of Washington (UW), as well as online directory searches using each state's transportation website (i.e., Washington State Department of Transportation and Oregon Department of Transportation). Researchers also implemented snowball sampling, in which current participants helped to identify additional candidates to interview. In total, 17 participants were interviewed from Washington (n=3), Idaho (n=1), Oregon (n=11), and Alaska (n=2). The topics and themes of the interview questions asked participants to discuss three major topics: 1) their access to or awareness of training opportunities; 2) the factors that affect their decision to attend training; and 3) perceived urgent or compelling needs within transportation engineering training. Each interview lasted approximately 15 minutes and was conducted over the phone; to protect participant identities, interviews were not audio recorded, but a researcher took field notes and used shorthand to capture quotes for later analysis.

Awareness and Access
Participants were asked to describe a typical training experience, including the means through which they heard about the training. Participants noted that most resources they might need were available and that access was a matter of taking the time to look. The following quote illustrates one participant's beliefs about how to find training opportunities.

> *Most things are there, but it's a matter of going out to get stuff. It's all available; it's just a matter of finding it and taking that step.*

In general, participants tended to find out about most training opportunities through some form of email list service. As individuals began to attend training sessions or joined various professional societies, the opportunities to find out about new training opportunities increased. Some participants also conducted online searches or reached out to training coordinators, but such actions were often in response to a specific training need.

Factors Affecting Training Decisions
A range of factors were noted as influential to the choice to attend training (or in the case of managers, to send an employee to training). For most participants, location and cost tended to drive training decisions. If travel was involved or if costs were too high, training opportunities often were more challenging.

> *Losing an employee for that time [can be costly]. If it [training] is closer it is nice ... webinars are nice.*

For managers, the costs of losing employee time due to travel for training purposes can be an economic barrier.

Another salient factor was the relevance of the training to current workplace needs. Further, if a training program or upcoming webinar was related to a project in the near future, the training was seen as more valuable.

The pertinence of the training to subdiscipline and job is a key factor.

Participants noted the importance of being able to gain practical skills they could apply in their jobs. Hands-on training was seen as especially valuable, in contrast to programs that educate on theories or rules. Such information was seen as less directly applicable to current work and therefore less important.

> *... being able to have hands on training ... being able to go away with actual tools that can be put to use instead of theory or what could happen ...*

In other words, congruence between training and upcoming work was a key driver in decision making related to attendance.

Current Training Topic Needs
The final portion of the structured interview asked participants to think of topic areas or content for which training would be helpful, but which does not currently exist. Most participants reiterated the importance of alignment of training topic area with current workplace demands, but some larger categories emerged from the discussion. In particular, there seemed to be persistent training needs surrounding topics related to updates on safety, operations, and maintenance. As laws and rules and regulations shift, it is important that engineers and managers are up-to-date on these changes.

> *The way we produce our documents is heavily reliant on technology and so having access [to training is important] ... even if the way they design roads hasn't changed, how they design them is always changing based on the technology available.*

As technology becomes more ubiquitous in traffic engineering, including the use of software, big data, and other applications, ensuring employee competence with these new advances is essential.

Phase 2: Survey Development and Distribution
The research team leveraged the interview findings to inform the development of survey items and response choices. By using this first qualitative phase to drive the second phase, the questions were empirically grounded in responses from practitioners. For example, when developing responses to questions related to factors affecting training decisions, interview responses were used to generate an initial list. Further, the topics noted by interviewees served as the basis for questions about upcoming training or topics of interest.

An online survey, consisting of 22 questions, was then distributed to individuals based on the personal contacts of the researchers in the four collaborative universities and to managers who had participated in the qualitative interviews. The following sections provide aggregated highlights across employee and manager groups. It is important to note that not all respondents completed the survey entirely or responded to all of the questions, and there were also questions

that respondents could select several choices. For these reasons, the total number of responses on particular items may have slightly different overall totals.

Results and Analysis

Participants were recruited through two different approaches. First, interview participants who were willing to distribute the survey were notified. Second, administrators from transportation entities such as PacTrans, the regional university transportation center, and state and local chapters of the Institute of Transportation Engineers were contacted and asked to broadly distribute the survey. A final total of 184 individuals responded to this survey, which consisted of both managers (n=63) and practitioners (n=121). Manager responses originated from Alaska (n=42), Washington (n=12), Oregon (n=7) and other states (n=2) while engineer responses were reflected by Oregon (n=46), Alaska (n=45), Washington (n=23) and other (n=5) responders. Responses from engineers and managers were separated to explore potential differences in perceptions surrounding training.

Table 2 provides an overview of the amount of experience reported. All managers reported having more than five years of experience in transportation engineering, while there was a wider range of experience for managers in their current positions. Perhaps unsurprisingly, compared to managers, engineers tended to have less experience both in transportation in general as well as in their current jobs.

TABLE 2 Participant experience overview

	Experience in transportation (yrs)				Experience in current job (yrs)			
	< 1	1 - 2	3 - 5	> 5	< 1	1 - 2	3 - 5	> 5
Managers	0	0	2	63	7	11	12	3
Engineers	5	9	12	93	27	22	20	51

In terms of the disciplines represented within transportation engineering, the results suggest a relatively diverse group of concentrations in specific fields (Table 3). In this case, respondents could select multiple responses, depending on the nature of their work. It is notable that a significantly high proportion identified "design" as a discipline, suggesting that such activities might be common across other focus areas. In terms of specific responses to the "Other" category, participants noted specific subdisciplines of transportation engineering such as "right of way", "hydraulics", or "bridges".

TABLE 3 Overview of discipline area for managers and engineers

	Traffic	Highway	Safety	Construction	Design	Consulting	Other
Managers	26	27	16	20	32	19	15
Engineers	38	53	30	34	56	18	32

Based on the findings from the interview data, several survey questions were developed to further explore awareness of and access to different training opportunities. For example, a better understanding of the frequencies with which transportation engineers and managers attend training or professional development was desired. Table 4 provides a summary of the frequencies in which managers and engineers attend internal and external training programs within a given year. It is important to note here that managers were asked how many times their average

employee attends training, while engineers were asked how many times they specifically attend training. As can be seen in Table 4, internal training opportunities appear much more common than external training.

TABLE 4 Training frequency comparison across managers and engineers

	Internal Training (times/year)					External Training (times/year)				
	0-1	2	3	4	5+	0-1	2	3	4	5+
Managers	12 (19%)	10 (16%)	14 (22%)	7 (11%)	20 (32%)	36 (57%)	20 (32%)	4 (6%)	3 (5%)	0 (0%)
Engineers	27 (22%)	28 (23%)	21 (17%)	17 (14%)	31 (25%)	71 (57%)	28 (23%)	10 (8%)	4 (3%)	11 (9%)

Survey participants were also asked how they found out about training opportunities. Questions were developed that probed for the ways respondents learn about training opportunities or programs (Table 5). Strong similarities in how training is discovered were noted, suggesting that there were common ways these individuals receive information about training. Though the responses developed in the survey captured most of the modes of dissemination, some participants noted periodically checking different websites for training events.

TABLE 5 Frequency and percentage of method of discovering training opportunities

	Internal Communication	Email Listserv	Word of Mouth	Online Ads	Professional Societies	Other
Managers	50 (34%)	25 (17%)	23 (15%)	16 (11%)	28 (19 %)	7 (5%)
Engineers	98 (38%)	52 (20%)	39 (15%)	22 (8%)	45 (17%)	5 (2%)

This study also sought to better understand support for and barriers to training. Therefore, participants were asked Likert-type questions regarding the importance of various factors, such as location, cost, and topic area. Table 6 illustrates the importance of different criteria for managers and engineers. In general, engineers and managers seemed to evaluate training decisions using similarly weighted criteria. The quantitative findings here echoed and corroborated findings from the interviews; some of the most important aspects of choosing training were related to location, cost, and topic area. These trends were qualitatively similar across managers and practicing engineers.

TABLE 6 Factors affecting training (1 = not at all important, 5 = extremely important)

	Engineers	Managers
Topic	4.30	4.52
Location	4.01	4.05
Cost	3.90	4.10
Professional Development	3.33	3.53
Timeliness	3.14	3.45
Employee Time-off	2.92	2.89
Networking	2.45	2.68

Survey questions also queried transportation managers and engineers with regard to specific topics and content areas in need of development. The categories from the interviews were distilled into seven overarching categories, and participants were asked to rate the importance of various topics in terms of timeliness of training needs. Table 7 details the manager and engineer

responses, respectively. In this dataset, engineers and their managers were in general agreement regarding the importance and timeliness on a range of different topics, with those topics primarily concerned with issues of accessibility (such as ADA compliance), changes in technology, and design.

TABLE 7 Topic importance (1 = not at all important, 5 = extremely important)

	Engineers	Managers
Design	3.76	3.68
Changes in Technology	3.68	3.52
Accessibility Compliance	3.51	3.47
Transportation Systems Management Operations	3.34	2.93
Performance Monitoring / Signal Systems	2.77	2.81
ITS Design and Application	2.72	2.63
Connected / Autonomous Vehicles	2.43	2.26

Lastly, survey respondents were asked to list topics for which they would like training but which is, in their opinion, not available or personally accessible. For this question, responses were open-ended and participants could provide any feedback desired. Though responses were optional and the possibility existed that there were no topics for which training was unavailable, managers (n=12) and engineers (n=31) both provided some commentary and Table 8 summarizes key topics of interest. It is worth noting that of the topics listed some were already available (based on the current offering exercise that was conducted as part of this study and described earlier in this paper). This finding suggests that awareness of these resources remains a potential sticking point.

TABLE 8 Topic examples for managers and engineers perceiving a need for training not actively available

Managers	Engineers
Data storytelling	Right of way
Professional (soft skills)	GIS training
Skip tracing and archive research	Team building and change management
System Operations	ADA compliance
Aviation base training	PE and FE exam workshops

Conclusions

The results from the two phases of the study provided triangulation and corroboration, and also point to some interesting trends. For instance, the *most important criteria for determining*

whether or not someone will attend training is driven by the relevance of the training topic to an upcoming project or job, but also comes down to cost and location. That is, most respondents do not consider training needs in broad scales or in terms of larger trajectories of the field, but instead make choices related to the immediacy of a need for training or a specific type of competence or certification. For example, topics such as connected vehicles were considered of low importance, while those related to changes in technology or updates on ADA compliance were often reported as a higher priority. These findings emerged from both interviews and survey responses, providing compelling evidence of their validity.

When seeking training, managers and engineers often utilized the same sources, and prioritized training in similar ways. However, some gaps exist across engineers and managers in terms of desired training needs that are not available. As described earlier, managers and engineers perceive different kinds of training needs with respect to professional development. *While managers emphasize professional development related to leadership or management or training, practitioners often link their perceived training needs to more specific kinds of skills or tasks* (i.e., learning new software or design techniques for particular roadway types). For these reasons, the results presented here suggest that training needs are more driven by reactions to changes in rules or regulations or changes in technology, and training programs should aim to more effectively anticipate these needs and design accordingly. For instance, a local effect observed in one state concerned issues of historical noncompliance with a subset of policies. As a result, much of their training efforts were in response to noncompliance and remedies to existing infrastructure. Efforts to anticipate training needs based on changes in policies can make training processes more expedient as well as relevant to employees and managers.

This study has demonstrated that much can be done to link transportation professionals with the tools and resources that are needed and provides insight to local technical assistance programs (LTAPs) as to the content and context of future training opportunities. In today's increasingly connected world, determining the appropriate key words and ensuring that important training opportunities actively appear at the top of a search engine list may, in fact, prove to be of greater importance in the short term than development of the content that is provided in the actual training. Given the range of sources and modes of dissemination, the development of an effective and widely accepted tool to streamline the query process would not only help managers and engineers locate the right kind of training for their needs but also mitigate the potential for any duplicative efforts by content designers.

Acknowledgment

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