

FINAL REPORT (BACKGROUND DOCUMENTATION)

to the

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM (NCHRP)

on Project 02-25

WORKFORCE 2030--ATTRACTING, RETAINING, AND DEVELOPING THE TRANSPORTATION WORKFORCE: DESIGN, CONSTRUCTION, AND MAINTENANCE

LIMITED USE DOCUMENT

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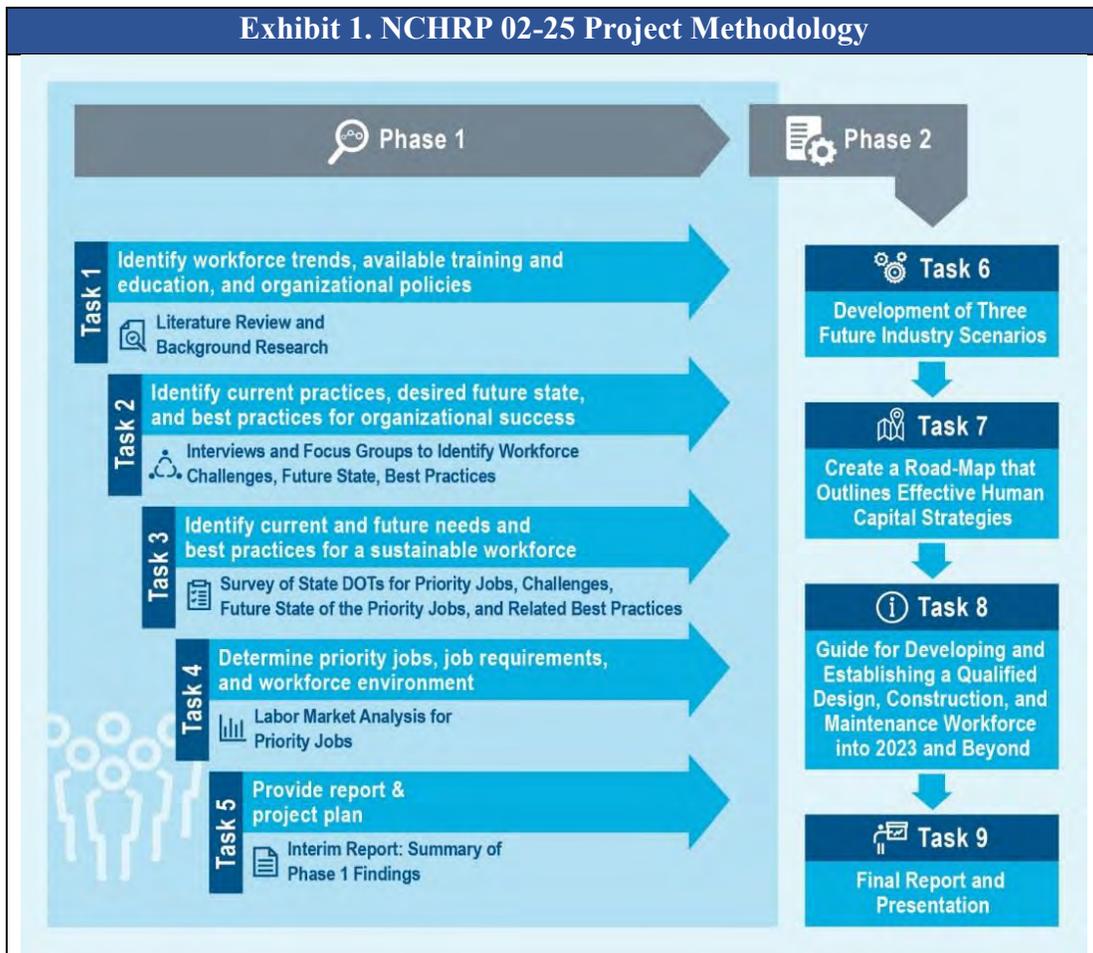
Background and Objectives of NCHRP Project 02-25, “Workforce 2030—Attracting, Retaining, Developing the Transportation Workforce: Design, Construction, and Maintenance”

The transportation design, construction, and maintenance workforce play a critical role in ensuring the integrity of our nation’s transportation infrastructure. Individuals in these career fields are trusted to make sure that the system is safe, efficient, and effective for our communities. Unfortunately, departments of transportation (DOTs) around the country are facing a confluence of challenges to maintain a strong workforce in these three areas. As stated in the initial solicitation, “Agencies are increasingly challenged by the availability and preparedness of the design, construction, and maintenance workforce” (<http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4544>). These challenges range from budget constraints coupled with the need to replace retiring staff to emerging technologies and new operational demands changing the way DOTs conduct their business. The reality is that the design, construction, and maintenance workforce of 2030 will look much different than what it does today. Compared to the workforce of today, the workforce of 2030 will be leaner, more infiltrated with private-sector contractors, and more technologically savvy.

To manage the dynamics of meeting tomorrow’s design, construction, and maintenance demands with a smaller workforce, state DOTs need robust human capital programs that can attract and train the engineers, technicians, and maintenance workers needed to maintain the U.S. highway infrastructure. The workforce shortage among state transportation agencies has evolved, and state DOTs recognize that challenges cannot be overcome without significant changes in workforce recruitment and training practices.

The purpose of NCHRP Project 02-25, “Workforce 2030-Attracting, Retaining, and Developing the Transportation Workforce: Design, Construction, and Maintenance” is to solidify the current industry trends and demands that will impact workforce needs for state DOTs in the future, particularly in the occupational areas of design, construction, and maintenance. Further, the project is aimed at developing practical resources to improve how state DOTs recruit, select, train, and sustain a capable workforce over the next 10+ years in light of significant labor market shifts, competitive forces, and industry changes. The project will also provide guidance at an industry level to help unite stakeholders in building workforce capacity across the industry, especially for jobs deemed mission critical and at great risk due to shortages in the talent pipeline.

To effectively meet the requirements of this project, ICF conducted nine tasks. The first five tasks comprised Phase 1, which occurred prior to the interim meeting. Phase 2 included the final four tasks and was completed after the interim meeting. Exhibit 1 provides an overview of the nine tasks.



Phase 1

The goal of Phase 1 was to develop an accurate understanding of current and anticipated industry trends and demands that will impact workforce needs for state DOTs. ICF first conducted a literature review in Task 1 to gather background knowledge about DOTs, such as how they vary across states, and identify emerging trends in the occupational areas of design, maintenance, and construction. With this background information, ICF completed focus groups with transportation professionals and DOT leaders in Task 2 to understand the industry challenges, environmental factors hindering or supporting these challenges, and ways DOTs and private-sector organizations have overcome these challenges. Within Task 3, ICF used the industry trends identified in Task 2 to develop and administer a survey that identified a list of priority jobs and sought to understand why these jobs will be essential for state DOTs in 2030 and beyond. ICF built upon these priority jobs in Task 4 by examining labor market data to articulate the functions and workforce demands for these jobs, and to analyze the pipeline, educational background, and labor pools for these jobs. Lastly, ICF produced an interim report during Task 5 that detailed the methodologies and findings for Tasks 1 through 4 and laid the foundation for Tasks 6 through 9 following in Phase 2.

Task 1: Literature Review and Background Research

The goal of Task 1 was to identify and define factors and trends in the transportation industry that are impacting state DOTs and the transportation workforce now and over the next 12 years. To accomplish this, ICF conducted a comprehensive literature review as well as organized and evaluated existing research about the transportation industry and workforce capacity needs related to design, maintenance, and construction occupations. We gathered information readily available about programs to support and meet these needs. The focus while gathering materials and research was on the following:

- Workforce trends and best practices for design, construction, and maintenance occupations.
- Availability of training and education related to workforce needs.
- Organizational structures, policies, and partnerships and how they vary across state DOTs.

ICF developed an electronic database and cataloged relevant transportation literature on workforce challenges as well as literature on best practices in human capital in areas such as recruitment, retention, and training. Further, the team focused preliminary research on workforce challenges specific to the occupational groups of design, construction, and maintenance. The research team identified seven major areas that affect workforce challenges for state DOTs. The literature was organized in our database under seven major categories: workforce needs; training and education; technological advances; policies and regulatory requirements; integration with contractors; resources, tools, and best practices; and recruitment, retention, and engagement. The categories are described in Exhibit 2.

| Exhibit 2. Descriptions of the Literature Review Categories | |
|---|--|
| Categories | Descriptions |
| Workforce Needs | Current and anticipated transportation industry workforce needs, the current state of the workforce pipeline, demographic changes, and challenges attracting, retaining, and developing staff currently and over the next 12 years. |
| Training and Education | Availability of training and education programs to address current and future workforce needs for design, construction, and maintenance occupations. |
| Technological Advances | Insight into technological advances in the transportation agency currently and over the next 12 years that will impact the capabilities and skills needed to perform effectively in design, construction, and maintenance occupations. |
| Policies and Regulatory Requirements | Policies and regulatory requirements that affect the roles and responsibilities of state DOTs as well as their ability to retain and develop the future workforce. |
| Integration with Contractors | Insight into the extent to which transportation agencies contract out services, helping to identify which services can be contracted out and which services are core to a transportation agency's operations and must be performed internally by agency staff. |

| Exhibit 2. Descriptions of the Literature Review Categories | |
|---|--|
| Categories | Descriptions |
| Resources, Tools, and Best Practices | Existing resources and tools (e.g., plans, templates, guides) that agencies have developed to aid in workforce and organizational capacity-building, along with a detailed catalog of any specific best practices that have been developed and researched by agencies. |
| Recruitment, Retention, and Engagement | Research and guidance for best recruiting, retaining, and engaging employees in the transportation industry or similar fields |

Within these categories, the team documented the following information about each article:

- Article title.
- Author(s).
- Year published/uploaded.
- Published or unpublished.
- Empirical or theoretical.
- Source type (technical reports, conference presentations, research in progress, and case studies).
- Industry (design, construction, and maintenance).
- Key findings and overview.
- Research limitations.
- Scientific relevance.
- Source of information (URL).
- Organization/agency providing information.
- Relevance to specific project tasks.

The team cataloged over 30 research pieces and submitted the database to the Cooperative Research Program’s Senior Program Officer (SPO) and the project’s panel. A table of all the sources reviewed during this literature search and their key findings can be found in Appendix A.

Task 2: Engage Stakeholders to Identify Workforce Challenges, Future State, and Best Practices

The purpose of Task 2 was to engage with leadership and key stakeholders from various transportation agencies and private organizations to gain a deeper understanding of current transportation workforce challenges as well as anticipated challenges and needs based on the future state of the industry. We gained insight into innovative practices that state DOTs and private-sector organizations are using to overcome these challenges, and we looked for evidence that speaks to the effectiveness of these practices in addressing challenges in attracting, retaining, and developing qualified employees. Further, we gathered information on existing organizational policies that support, hinder, or in some way impact retention of the current workforce and development of the future one.

To gather this information, ICF conducted focus groups and interviews with 85 transportation professionals and DOT leaders using protocol questions previously reviewed by the panel (see

Appendix B for the protocol questions). To recruit participants for our data collections, ICF leveraged existing state DOT contacts. We also conducted outreach to ASHTO committees—particularly those representing design, construction, and maintenance—to obtain experts in these occupational fields to review preliminary job lists. Further, ICF worked with our experts that represent a number of the regional workforce centers to identify contacts and potential opportunities our team could leverage for additional outreach to DOTs.

Interview and focus group participants represented DOTs from across the United States who held long tenure within transportation agencies (average of about 20 years). Occupations of these stakeholders ranged from transportation agency directors to construction directors, hydraulic engineers, bridge engineers, human resource directors, and branch managers (see Appendix C for the list of participants). Participants shared their views on industry-wide trends likely to impact the maintenance, design, and construction jobs in the future. ICF also generated a preliminary list of job titles under each of the three target occupations and vetted this with stakeholders during data collection. More details on the jobs list are discussed under Task 3.

After conducting the interviews and focus groups, ICF performed a thematic analysis of the narrative results. The project team sorted this qualitative data into human capital challenges, trends and solutions, or best practices. This structure and the resulting themes informed the narrative of the “Overview of Major Findings and State DOT Practices” in Appendix D.

ICF then hosted a roundtable session with our five expert advisors where we reviewed the overview of major findings and state DOT practices in an effort to reconcile any relevant trends, challenges, or solutions that did not emerge during the initial data collections. ICF recorded advisors’ feedback and noted several examples of the solutions and best practices that have the potential to be replicated around the country and presented in the [Roadmap and Guide](#).

Various themes emerged during the interviews and focus groups, which made it clear that DOTs across the United States are grappling with some of the same challenges despite their geographical differences. These themes are summarized in Exhibit 3.

| Exhibit 3. Themes of Industry Challenges from Task 2 Data Collections | |
|--|---|
| Trend/Challenge | Description |
| Adoption of New Technologies | The adoption of new technologies is changing current job roles and necessary workforce knowledge, skills, and abilities (KSAs). This is especially true for the domains of data science and statistical analysis. |
| Economic Challenges | The tumultuous national economy is affecting the level of competition between DOTs and other employers for the same pool of potential employees. |
| Rise of Multi-Modal Transportation | Multi-modal transportation is growing in popularity and DOTs around the country are having to change the way they approach design, construction, and maintenance work in response. |

| Exhibit 3. Themes of Industry Challenges from Task 2 Data Collections | |
|---|--|
| Trend/Challenge | Description |
| Resiliency Planning | DOTs and the transportation industry as a whole must prepare for the environmental shocks and stresses and build environmental considerations into the work they do. |
| Blue-Collar Stigma | Blue-collar work, including construction and design work, is wrongly stigmatized. DOTs are challenged with confronting this sentiment as well as debunking other misconceptions that affect their recruitment efforts. |
| Slow Hiring Practices | DOTs are burdened by slow hiring practices, which ultimately affect the way they attract and hire new employees. This puts DOTs at a disadvantage when compared to private employers. |
| Popularity and Expectation of Flexible Workplace Policies | Flexible workplace policies, such as the ability of employees to work remotely or make their own schedule, are becoming more common to the point where some people expect these things from their employers. DOTs have been slow to adopt such policies and are suffering as a result. |
| Difficulty Recruiting and Retaining Mid-Level or Young Staff | DOTs are struggling to recruit and retain mid-level or young staff in the areas of design, construction, and maintenance. These organizations often have to promote low-level staff to fill these vacancies, creating a considerable and troubling knowledge gap. |
| Steady Downsizing Of DOT Staff and the Increased Reliance on Contractors | The increased reliance on contractor support means more managing and less “doing.” This trend has created the need to develop project management and communication KSAs in the workforce. |
| Generational Differences | Older generations and younger generations can perceive transportation work differently. This is especially true for integrating new technologies into day-to-day operations. Generational differences can also manifest in preferences for training and workforce development. |

The additional challenges that ICF identified in collaboration with our five industry advisors included:

- Lack of skilled purchasing/contracting personnel.
- Hiring and retaining maintenance employees in particular.
- Attracting and retaining a diverse workforce, especially women.
- Retaining supervisors in particular.
- Competition from local public transportation agencies when it comes to hiring.
- Securing investment in internal training and education programs.

While the focus of Phase 2 was to identify best practices and develop feasible strategies, the thematic analysis from Task 2 also revealed potential solutions and best practices. These themes are presented in Exhibit 4, each corresponding to one or more of the challenges presented in Exhibit 3. ICF and its expert advisors made sure to note where (i.e., in which DOT) these best practices are being used to identify possible Phase 2 case study participants.

| Exhibit 4. Themes of Best Practices from Task 2 Data Collections | |
|---|---|
| Solution/Best Practice | Potential Case Study Examples |
| <p>Partner with local grade schools, community colleges, trade schools, and universities to</p> <ul style="list-style-type: none"> ▪ Recruit new, young employees in the design, construction, and maintenance career fields; ▪ Ensure curriculums are aligned with the changing nature of work and changing KSAs; and ▪ Help challenge negative perceptions of DOT work and challenge blue-collar stigma. | <p>California, Georgia, Kentucky, Massachusetts, Michigan, Minnesota, Tennessee, Utah, Virginia, Washington, DC, Washington State</p> |
| <p>Engage with nontraditional pools of potential employees (i.e., veterans, individuals with disabilities, and individuals with prior convictions) to widen the workforce pipeline and increase diversity.</p> | <p>Arizona, California, Minnesota, New Hampshire, Texas, Vermont, Washington State</p> |
| <p>Implement internship and apprenticeship programs to give potential employees a taste for the work and hopefully hire talented full-time staff.</p> | <p>Indiana, Massachusetts, Michigan, New Jersey, Virginia</p> |
| <p>Adjust hiring practices to make hiring new employees easier and quicker for all parties. This includes removing certain requirements for certifications (i.e., Commercial Drivers Licenses) and skills that can be obtained after a person is hired.</p> | <p>Michigan, Minnesota</p> |
| <p>Update job descriptions to account for changes in roles, responsibilities, and needed KSAs, especially data science, statistics, project management, and communication.</p> | <p>TBD</p> |
| <p>Partner with professional associations such as the Women’s Transportation Seminar (WTS), the National Action Council for Minorities in Engineering (NACME), the American Indian Science and Engineering Society (AISES), and others to promote workforce diversity.</p> | <p>TBD</p> |
| <p>Initiate a marketing campaign to rebrand the public image of state DOTs to highlight desirable aspects of design, construction, and maintenance career fields such as:</p> <ul style="list-style-type: none"> ▪ Civic duty. ▪ A sense of ownership of the infrastructure projects in the local community. ▪ Job stability. ▪ Better work-life balance compared to the private sector. | <p>Kansas, New Jersey</p> |

| Exhibit 4. Themes of Best Practices from Task 2 Data Collections | |
|---|---|
| Solution/Best Practice | Potential Case Study Examples |
| Consider the viability of implementing flexible workplace policies and engage staff to come up with alternatives that may be just as effective in raising employee satisfaction. | Massachusetts, Washington State |
| Ask new hires about their expectations when they first begin working for a DOT and conduct debriefs interviews with staff who leave the organization to better understand gaps leading to retention issues. | Washington State |
| Implement formal and informal knowledge management initiatives such as mentorship or career coaching programs to facilitate knowledge transfer and to keep employees engaged. | California, Delaware, Idaho, Indiana, Michigan, Vermont, Washington State |
| Implement cross-training programs and career roadmaps where employees can receive training in multiple career fields and opt to pursue the area of work that best suits them. | Indiana, Michigan, Nebraska, New Jersey, Texas |
| Offer more training and career development opportunities to provide staff with the KSAs they need to be successful. | Arkansas, Idaho |
| Foster innovative thinking through employee-driven programs to generate solutions to current and future transportation problems. | Maryland, Missouri, North Dakota |

Task 3: Survey of State DOTs for Priority Jobs, Challenges, Future State of the Priority Jobs, and Related Best Practices

This task included conducting an industry-wide web survey to assess the prevalence and impact of industry trends on the future job requirements in transportation design, construction, and maintenance occupations. This survey allowed the team to identify an initial list of jobs that may be critical within the key occupational areas and expand understanding of those jobs that will be critical to accomplishing the mission and goals of state DOTs as we near 2030 and beyond. These priority jobs (also known as mission critical jobs) covered not only jobs that are needed for continuity of operations but also jobs for which the talent pipeline is sparse or near obsolete, thus requiring state DOTs to be intentional, and sometimes creative, in preparing for the future and potential skill deficits. Defining priority jobs is an important step because state DOTs need to know how to best allocate resources and where human capital strategies are immediately needed to ensure workforce and agency sustainability.

The ICF team researched U.S. Department of Labor (DOL) occupational classifications to prepare a comprehensive, preliminary list of jobs that could be used as stimuli for gathering survey data. ICF discussed this list of jobs with state DOTs within the Task 2 interviews. ICF provided the jobs list to the project panel members and requested panelists to review the list to confirm it reflected the major job titles within the occupations of transportation construction, maintenance, and design. The purpose of this list was to gather rankings of these jobs within the mission critical jobs survey.

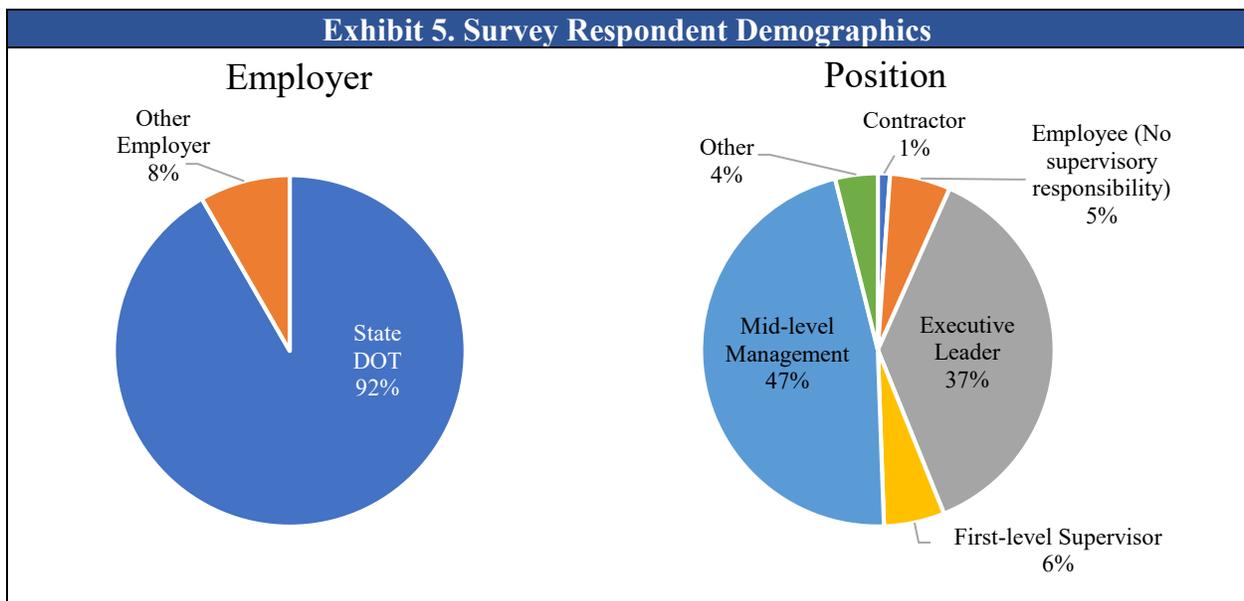
Once confirmed, this list of possible jobs within each of the three target occupational fields was incorporated into the survey. ICF also worked with industry experts and internal industry advisors to identify a common set of DOT goals that drive the mission of most DOTs. While ICF structured the survey to first ask participants to rank order job types based on their priority to the industry, we also gathered priority jobs using a secondary line of inquiry where we presented questions about the extent to which the job would align to common DOT goals and mission achievement and result in catastrophic outcomes should the job remain vacant for a substantial amount of time.

The survey content was programmed and administered in an online web-survey format using Verint software. The complete survey is provided in Appendix E. ICF distributed the survey to approximately 600 DOT professionals across the country. At the close of the survey, 180 participants completed the survey. Since people could answer questions for more than one of the occupations, we have the following numbers of participants in the analysis by occupational group:

- Construction: *N* = 81
- Design: *N* = 80
- Maintenance: *N* = 68

Survey Results

Most participants were employed by state DOTs (92%, *n* = 165). Additionally, the greatest percentage of respondents identified themselves as mid-level management (47%, *n* = 84). Forty-six states plus the District of Columbia were represented in the survey responses. Exhibit 5 features this demographic information.

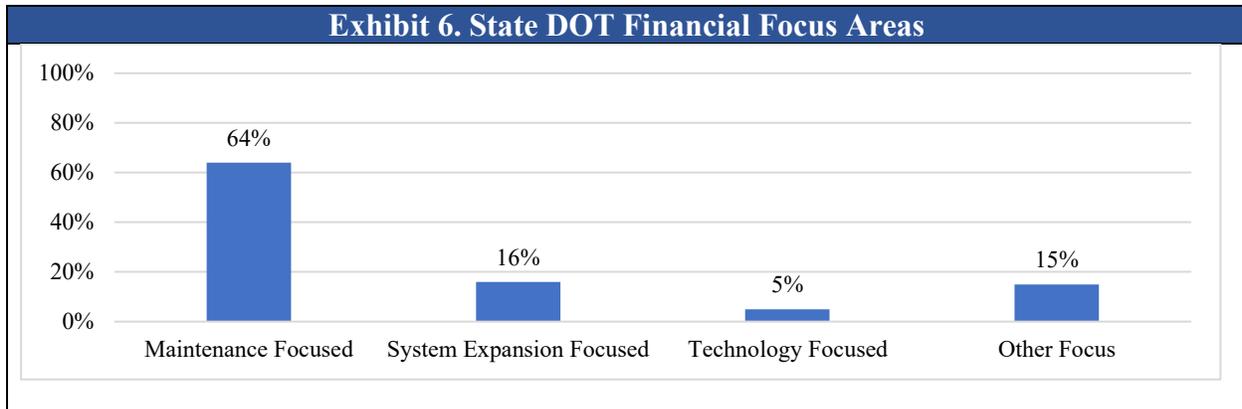


Survey participants who were employed by state DOTs were asked to provide details about their DOT. For example, participants answered questions about

- DOT/organizational demographics for their department,
- Personal demographics (e.g., tenure, job title),

- Specific workforce challenges experienced,
- Current capability gaps (e.g., skills, knowledge), and
- Examples of existing training or education programs that are valuable.

Participants were also asked about the financial focus of their DOT. Most respondents indicated that their DOT's financial focus was primarily on maintenance functions (64%, n = 106). Exhibit 6 provides all responses to this question about financial focus. Other focus areas included Asset Management, Capacity, Operation, Project, Safety, and System Preservation, as well as a combination of the types listed.



Survey Content and Identification of Priority Jobs

As previously described, survey respondents were asked to indicate which of the three occupational areas they were most familiar with (i.e., construction, design, and/or maintenance), and were provided with questions only about the selected occupational areas. Once the occupational areas were selected, participants were asked to review a list of jobs within the occupational area and select three that they felt were the highest priority or most critical to the mission of state DOTs. They then responded to questions about each of the selected jobs to identify current and future workforce challenges as well as the extent to which the job impacts state DOT goals. The state DOT goals included were;

- Provide equitable multi-modal access and connectivity for community prosperity;
- Provide a safe and reliable transportation system;
- Leverage technological advances to improve transportation convenience and safety;
- Support a vibrant economy and economic vitality;
- Preserve and enhance infrastructure;
- Deliver the right project on time and on budget;
- Promote stewardship and preserve transportation system investments, protect the environment, and responsibly utilize public resources; and
- Deliver quality service through excellent employee performance, public communication, and accountability.

Additionally, for each priority job selected within the three target occupational fields, participants answered questions about

- Current challenges for the priority job roles,
- Impact of the priority job roles on achieving various state DOT goals, and

- Future challenges for the priority job roles.

To identify the priority jobs in each occupational area, we used the percentage of respondents who placed it in their top three. Additionally, we created a composite score of the impact of the job on state DOT goals to confirm that the priority jobs are in fact important for state DOTs and their ability to achieve these goals over the next 10 years.

The following sections present the five top priority jobs within each of the three occupational areas, based on the survey findings. The findings also identify the greatest current and future challenges for each job indicated by the survey respondents.

Priority Jobs: Design Occupations

A total of 80 respondents provided data regarding jobs in the design occupation. Exhibit 7 provides the percentage of respondents who identified each of the top priority jobs in their list of the top three design jobs, the average impact of the job on state DOT goals, and the greatest current and future challenges related to the job. Across the top five priority jobs within design, high competition across industries for needed skill sets and having a small applicant pool available to fill vacancies were common current challenges.

| Exhibit 7. Survey Findings on Design Occupations | | | | |
|--|--|--|--|---|
| Design Priority Job Role | Percentage of Respondents Selecting Job in the Top 3 | Impact on State DOT Goals ¹ | Greatest Current Challenges | Greatest Future Challenges |
| Bridge and Structural Designer | 53% | 4.29 | <ul style="list-style-type: none"> ▪ High competition across industries for skill sets required better compensation, or job attractiveness elsewhere. ▪ Small applicant pool when/if needing to fill a vacancy. ▪ Highly specialized skill set required for this job, making finding employees difficult. | <ul style="list-style-type: none"> ▪ Consequences of error will pose significant costs or challenges. ▪ Will be at risk for vacancy in the next 10–15 years due to turnover or retirement. ▪ Because of knowledge loss due to retirements, will need additional developmental opportunities. |

¹ This rating ranges from 1 (Not at All) to 5 (Extremely) regarding how impactful the job is on state DOT goals.

| Exhibit 7. Survey Findings on Design Occupations | | | | |
|--|--|--|---|--|
| Design Priority Job Role | Percentage of Respondents Selecting Job in the Top 3 | Impact on State DOT Goals ¹ | Greatest Current Challenges | Greatest Future Challenges |
| Civil Engineer | 43% | 4.39 | <ul style="list-style-type: none"> ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ Small applicant pool when/if needing to fill a vacancy. ▪ High level of turnover. | <ul style="list-style-type: none"> ▪ Emerging technologies will require new skill sets for employees. ▪ Because of changing job requirements or work activities, employees will need new or additional training. ▪ Complexity of tasks performed will increase significantly in the next 10–15 years. |
| Transportation Engineer | 45% | 4.39 | <ul style="list-style-type: none"> ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ Small applicant pool when/if needing to fill a vacancy. ▪ High level of turnover. | <ul style="list-style-type: none"> ▪ Emerging technologies will require new skill sets for employees. ▪ Because of changing job requirements or work activities, employees will need new or additional training. ▪ Complexity of tasks performed will increase significantly in the next 10–15 years. |
| Transportation Planner | 44% | 4.24 | <ul style="list-style-type: none"> ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ Small applicant pool when/if needing to fill a vacancy. ▪ Skill set required for this job is highly specialized, making finding employees difficult. | <ul style="list-style-type: none"> ▪ Because of changing job requirements or work activities, employees will need new or additional training. ▪ Because of knowledge loss due to retirements, employees will need additional developmental opportunities. ▪ Changing demographics, such as having a younger and/or more diverse labor pool, is likely to impact the Transportation Planner workforce in DOTs. |

| Exhibit 7. Survey Findings on Design Occupations | | | | |
|--|--|--|---|--|
| Design Priority Job Role | Percentage of Respondents Selecting Job in the Top 3 | Impact on State DOT Goals ¹ | Greatest Current Challenges | Greatest Future Challenges |
| Traffic Engineer | 43% | 4.33 | <ul style="list-style-type: none"> ▪ Small applicant pool when/if needing to fill a vacancy. ▪ Skill set required for this job is highly specialized, making finding employees difficult. ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. | <ul style="list-style-type: none"> ▪ Because of changing job requirements or work activities, employees will need new or additional training. ▪ Emerging technologies will require new skill sets for employees. ▪ Complexity of tasks performed will increase significantly in the next 10–15 years. |

Priority Jobs: Construction

A total of 81 respondents provided data regarding jobs in the construction occupation. Based on these data, the following jobs were indicated as the top priority within construction. Exhibit 8 provides the number of respondents who identified the job as one of the top three construction jobs, the average impact of the job on state DOT goals, and the greatest current and future challenges related to the job. For the top four priority jobs, high competition for employees and a small applicant pool are some of the greatest workforce challenges faced. In terms of future challenges, it is expected that emerging technologies requiring new skill sets will impact all five of the priority jobs in construction.

| Exhibit 8. Survey Findings on Construction Occupations | | | | |
|--|--|--|---|---|
| Construction Priority Job Role | Percentage of Respondents Selecting Job in the Top 3 | Impact on State DOT Goals ² | Greatest Current Challenges | Greatest Future Challenges |
| Civil Engineer | 83% | 4.43 | <ul style="list-style-type: none"> ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ Small applicant pool when/if needing to fill a vacancy. ▪ High level of turnover. | <ul style="list-style-type: none"> ▪ Will be at risk for vacancy in the next 10–15 years due to turnover or retirement. ▪ Because of knowledge loss due to retirements, employees will need additional developmental opportunities. ▪ Emerging technologies will require new skill sets for employees. |
| Construction Manager | 59% | 4.23 | <ul style="list-style-type: none"> ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ Small applicant pool when/if needing to fill a vacancy. ▪ Skill set required for this job is highly specialized, making finding employees difficult. | <ul style="list-style-type: none"> ▪ Emerging technologies will require new skill sets for employees. ▪ Will be at risk for vacancy in the next 10–15 years due to turnover or retirement. ▪ Because of changing job requirements or work activities, employees will need new or additional training. |
| Transportation Construction Inspector | 35% | 4.09 | <ul style="list-style-type: none"> ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ Small applicant pool when/if needing to fill a vacancy. ▪ High level of turnover. | <ul style="list-style-type: none"> ▪ Emerging technologies will require new skill sets for employees. ▪ Will be at risk for vacancy in the next 10–15 years due to turnover or retirement. ▪ Will be difficult to fill in the next 10–15 years due to insufficient skill sets, knowledge, or interest within the labor market. |

² This rating ranges from 1 (Not at All) to 5 (Extremely) regarding how impactful the job is on state DOT goals.

| Exhibit 8. Survey Findings on Construction Occupations | | | | |
|--|--|--|--|---|
| Construction Priority Job Role | Percentage of Respondents Selecting Job in the Top 3 | Impact on State DOT Goals ² | Greatest Current Challenges | Greatest Future Challenges |
| Transportation Technician | 17% | 4.13 | <ul style="list-style-type: none"> ▪ High level of turnover. ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ Small applicant pool when/if needing to fill a vacancy. | <ul style="list-style-type: none"> ▪ Emerging technologies will require new skill sets for employees. ▪ Will be difficult to fill in the next 10–15 years due to insufficient skill sets, knowledge, or interest within the labor market. ▪ Will be at risk for vacancy in the next 10–15 years due to turnover or retirement. |
| Traffic Management Operator | 11% | 4.43 | <ul style="list-style-type: none"> ▪ Lack of training and development to support technical skills. ▪ Lack of credentialed education programs to prepare workers for real-world requirements in a DOT setting. ▪ Lacks solid career track in DOTs. | <ul style="list-style-type: none"> ▪ Emerging technologies will require new skill sets for employees. ▪ Because of changing job requirements or work activities, employees will need new or additional training. ▪ Complexity of tasks performed will increase significantly in the next 10–15 years. |

Priority Jobs: Maintenance

A total of 68 respondents provided data regarding jobs in the maintenance occupation. Exhibit 9 provides the percentage of respondents who identified each of the top priority jobs in their list of the top three maintenance jobs, the average impact of the job on state DOT goals, and the greatest current and future challenges related to the job. Within this list of priority jobs, the Snowplow Operator and Transportation Maintenance Specialist jobs have goal impact ratings that are slightly lower than other jobs; however, they were still indicated as among the highest priority jobs. Interestingly, Snowplow Operator arose as a priority job even though it is not something that is required in all states. One respondent even indicated that their state did not require Snowplow Operators, but the respondent still saw it as a top priority job.

| Exhibit 9. Survey Findings on Maintenance Occupations | | | | |
|---|--|--|---|---|
| Maintenance Priority Job Role | Percentage of Respondents Selecting Job in the Top 3 | Impact on State DOT Goals ³ | Greatest Current Challenges | Greatest Future Challenges |
| Highway Foreman | 40% | 4.13 | <ul style="list-style-type: none"> ▪ Lack of credentialed education programs to prepare workers for real-world requirements within a DOT setting. ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ Small applicant pool when/if needing to fill a vacancy. | <ul style="list-style-type: none"> ▪ Because of changing job requirements or work activities, employees will need new or additional training. ▪ Because of knowledge loss due to retirements, employees will need additional developmental opportunities. ▪ Emerging technologies will require new skill sets for employees. |
| Highway Maintenance Technician | 38% | 3.95 | <ul style="list-style-type: none"> ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ High level of turnover. ▪ Lack of credentialed education programs to prepare workers for real-world requirements within a DOT setting. | <ul style="list-style-type: none"> ▪ Will be at risk for vacancy in the next 10–15 years due to turnover or retirement. ▪ Emerging technologies will require new skill sets for employees. ▪ Changing demographics, such as having a younger and/or more diverse labor pool, is likely to impact the Highway Maintenance Technician workforce in DOTs. |
| Civil Engineer | 37% | 4.46 | <ul style="list-style-type: none"> ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ High level of turnover. ▪ Small applicant pool when/if needing to fill a vacancy. | <ul style="list-style-type: none"> ▪ Emerging technologies will require new skill sets for employees. ▪ Because of knowledge loss due to retirements, employees will need additional developmental opportunities. ▪ Because of changing job requirements or work activities, employees will need new or additional training. |

³ This rating ranges from 1 (Not at All) to 5 (Extremely) regarding how impactful the job is on state DOT goals.

| Exhibit 9. Survey Findings on Maintenance Occupations | | | | |
|---|--|--|--|--|
| Maintenance Priority Job Role | Percentage of Respondents Selecting Job in the Top 3 | Impact on State DOT Goals ³ | Greatest Current Challenges | Greatest Future Challenges |
| Snowplow Operator | 37% | 3.84 | <ul style="list-style-type: none"> ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ High level of turnover. ▪ Lacks solid career track in DOTs. | <ul style="list-style-type: none"> ▪ Will be at risk for vacancy in the next 10–15 years due to turnover or retirement. ▪ Changing demographics, such as having a younger and/or more diverse labor pool, is likely to impact the Snowplow Operator workforce in DOTs. ▪ Consequences of error by an employee will pose significant costs or challenges. |
| Transportation Maintenance Specialist | 35% | 3.88 | <ul style="list-style-type: none"> ▪ Small applicant pool when/if needing to fill a vacancy. ▪ High competition across industries for skill sets required, better compensation or job attractiveness elsewhere. ▪ High level of turnover. | <ul style="list-style-type: none"> ▪ Because of changing job requirements or work activities, employees will need new or additional training ▪ Changing demographics, such as having a younger and/or more diverse labor pool, is likely to impact the Transportation Maintenance Specialist workforce in DOTs ▪ Emerging technologies will require new skill sets for employees. |

Task 4: Labor Market Analysis for Priority Jobs

This task involved understanding the existing labor market for the priority jobs identified in Task 3. Part of this task examined publicly available employment data from sources such as DOL as well as searching job postings to better understand the competitive market and critical information about the priority jobs. We gathered labor market data to

- Define critical work functions for priority jobs,
- Estimate workforce demand for priority jobs, and

- Analyze the priority job in the workforce pipeline, education system, and available labor pools.

Using the DOL Standard Occupational Classifications (SOCs) for jobs identified in the top five of priority (within the three occupational areas) from Task 3, the ICF team conducted a labor market analysis to assess supply and demand for these jobs across industries. ICF gathered labor market projections from the U.S. Bureau of Labor Statistics (BLS) data; the data provided projections related to annual wage changes predicted, projected changes in the number of employees from now to 2028, and changes in the annual number of job openings projected. Our research team also reviewed job posting data from Burning Glass, which is a tool that provides information about job posting trends to identify which jobs are in high demand and indications about regional variation in postings. Following this analysis, ICF created job-specific profiles that showcased regional trends, skill needs, average compensation, and employee projections for each of the priority jobs. Since civil engineer was identified as a priority job across all three occupations, 13 total profiles were created.

Task 5: Interim Report: Summary of Phase 1 Findings

ICF prepared an interim report that described the methodology followed to conduct Tasks 1 through 4 and the results of these research activities and analysis. This report also included a draft summary of best practices and programs to address transportation workforce needs and organizational challenges that state DOTs will face over the next 12 years as well as a high-level description of anticipated Phase 2 final products for the project panel's review, feedback, and approval. The goal of this interim report was to present not only the Phase 1 methodology and findings but also to lay the groundwork for the Roadmap and Guide that would be developed in Phase 2. ICF prepared the interim report and submitted it to the NCHRP SPO.

In addition to the interim report, ICF prepared and conducted a formal interim briefing with the project panel. In the meeting, ICF discussed input that was provided by one panelist and presented the workplan for Phase 2. The SPO and panelists agreed that ICF should proceed as planned for Phase 2.

Phase 2

The purpose of Phase 2 was to articulate best practices, strategies, and supporting tools required by the industry to address the gaps and issues identified during Phase 1. To accomplish this, Tasks 6 through 9 were conducted. In Task 6, ICF hosted "futuring" workshops to determine how design, construction, and maintenance will need to respond, how these occupations may need to evolve, and to establish a framework that articulates the implications of future scenarios. The result of Task 7 was an Industry Framework designed to help cultivate a community perspective across transportation design, construction, and maintenance organizations and external entities that have the resources and leverage to influence strategy, infrastructure, the educational system, labor perspectives, and policymaking pertaining to the future transportation workforce. ICF then completed Task 8, which produced a user-friendly Roadmap and Guide that transportation organizations may use for developing and establishing a human capital program for a qualified design, construction, and maintenance workforce. Lastly, ICF created this document and a final briefing for Task 9 so that all the project tasks, methodologies, and results

were thoroughly documented. By completing these tasks, ICF hopes to enhance workforce capacity-building for design, construction, and maintenance occupations

Task 6: Conduct Development of Future Industry Scenarios

The purpose of this task was to build on the research and analysis conducted in Phase 1 to

1. Define scenarios that describe potential DOT operating environments to which design, construction, and maintenance will need to respond;
2. Determine how the careers themselves might evolve due to changing technologies, demographics, and applicant interests; and
3. Establish a framework to assist with analyzing the likely future scenarios and determining the implications of those future scenarios for workforce capacity-building over the next 10 years.

ICF worked with its expert advisory panel from universities and regional workforce centers to generate realistic content (i.e., scenarios) that served as stimuli for the futuring workshops.

Due to workspace and operational changes of the COVID-19 pandemic that have significantly impacted transportation, ICF prepared and conducted virtual futuring workshops with state DOT leaders. The sample of participants was identified during Phase 1 data collections based on their expertise in transportation design, maintenance, and/or construction and their future-oriented perspective. ICF developed a protocol to guide the virtual workshops. The logistics for the workshops included scheduling a lead ICF facilitator, notetaker, and one of our industry experts to sit in on each focus group. As a result of repeated outreach, ICF scheduled and led four futuring workshops with a total of 15 different participants representing 13 different state DOTs.

ICF conducted a qualitative analysis of the themes and responses from these futuring workshops. With these analyses, ICF identified eight futuring scenarios. ICF then hosted a follow-up round table session with our five expert advisors to polish the final set of futuring scenarios and ensure consistency in structure across the scenarios.

After refining the scenarios, the ICF research team agreed that two of the futuring scenarios addressed similar topics (i.e., diversity) and thus, those two scenarios were consolidated resulting in a final seven futuring scenarios. These futuring scenarios are situations likely to affect DOTs across the country and workforce needs over the next 5 to 10 years. Topics addressed in these scenarios include generational differences, diversity and inclusion, lack of skilled labor, changing workforce demographics, reduced budgets, new technologies, and changes in mobility patterns.

After finalizing the futuring scenarios, ICF developed and submitted the Workforce 2030 Summary Report (see Appendix F). The Summary Report describes the methodology used to identify probable future states for DOTs over the next 5 to 10 years as well as how those states will impact the disciplines of design, construction, and maintenance. The Summary Report also features the final seven futuring scenarios and discusses the implications of each scenario on workforce capacity-building for the future.

Task 7: Create Industry-Level Strategy and Framework for the Building 2030 Workforce Pipeline

The objective of this task was to create a vision that encourages stakeholders to collaborate across all aspects of the workforce pipeline. This framework was built based on the intersection of the scenario planning workshop results and Phase 1 findings. The framework considers the broader environment and network within which state DOTs operate. This framework serves as a holistic model to coordinate participation across external organizations at state and national levels that intersect with transportation construction. The framework also coordinates participation by highlighting the specific roles, responsibilities, and opportunities for these organizations to successfully build workforce capacity for this industry. This framework is ultimately designed to help cultivate a community perspective across transportation design, construction, and maintenance organizations and external entities that have the resources and leverage to influence strategy, infrastructure, educational systems, labor perspectives, and policymaking pertaining to the future transportation workforce.

To develop the Industry Framework, ICF conducted internal working sessions and industry research to flesh out the roles key transportation stakeholders play in building the talent pipeline and capacity across maintenance, design, and construction occupations within DOTs. ICF worked closely with expert advisors—three of whom represent FHWA Regional Workforce Centers—to identify some of these roles that stakeholders do or should have in that process. ICF also gathered and incorporated suggestions about additional partners to feature in the report.

In addition to gathering research of publicly available information and from our advisors, ICF conducted interviews with a subset of industry stakeholders and partners ($n = 11$ individuals) who were identified as strong partners in transportation. These individuals were identified by our expert advisors and project panelists as individuals who could offer additional perspectives on how the industry might approach workforce capacity-building from a multipartner, industry-wide, and national vantage point. The individuals who agreed to participate in interviews are in Exhibit 10.

| Exhibit 10. List of Interview Participants and Their Organizations | |
|--|---------------------|
| Organizations | Names |
| FHWA, Northeast Transportation Workforce Center | Glenn McCrae |
| FHWA, Southwest Transportation Workforce Center | Tom O'Brien |
| FHWA, West Transportation Workforce Center | Susan Gallagher |
| AASHTO/Alaska DOT | Amanda Holland |
| AASHTO | Brandye Hendrickson |
| National Transportation Training Directors (NTTD) /Wyoming DOT | James Boyd |
| Institute of Transportation Engineers (ITE) | Jeff Paniati |
| National Association of County Engineers (NACE) | Andy Avery |
| Wyoming Department of Transportation | Kent Ketterling |
| Wyoming Department of Transportation | Marc Anderson |
| Wyoming Department of Transportation | Ken Keel |

The protocol used to conduct these interviews is provided in Appendix G. It is important to note that some of the questions were adapted slightly within the interview to obtain the contextual information needed to complete the Industry Framework.

The final Industry Framework describes the role of each partner and addresses how small, medium, and large state DOTs can make progress toward their objectives and workforce development goals while keeping pace with technological advancements, skill needs, and competition. ICF provided the Industry Framework to the NCHRP SPO for the project panelists' feedback and submitted the final version with their feedback incorporated (see Appendix H for the Industry Framework).

Task 8: Create Roadmap and Guide for Developing and Establishing a Qualified Design, Construction, and Maintenance Workforce into 2030 and Beyond

In Task 8, we synthesized the information gathered in prior tasks into a practical, user-friendly Roadmap and Guide that transportation organizations may use for developing and establishing a human capital program for a qualified design, construction, and maintenance workforce. While Task 7 resulted in a framework that outlines a vision to take the industry from 2019 to 2030, the Roadmap and Guide provide DOTs with the resources they need to implement that vision locally, no matter their context or size. While it is recommended that the Guide be used in its entirety, each strategy is presented in a format that could easily be extracted by users to implement a new initiative.

ICF developed action plans and tools for 22 workforce strategies that directly align to the highly plausible seven future states and the workforce capacity-building challenges identified through this project research. These 22 strategies are intended to provide DOTs and stakeholders with approaches that will help to build a more solid workforce pipeline in the disciplines of design, construction, and maintenance.

The ICF Principal Investigator and SPO agreed that requesting project panelists to participate in working sessions would be an excellent way to vet these strategies and gather additional expert input to help refine them. ICF prepared outreach memos and emails for the SPO to share with project panelists to request their participation in upcoming 90-minute working sessions. The ICF team also prepared and sent draft materials for the panelists to review in advance of the working sessions. In addition, ICF prepared protocol questions to guide the working session discussions (see Appendix I for protocol questions).

Each panelist participated in two different sessions to cover all strategies. Every working session covered four to five strategies to make the sessions reasonable in length and to dig deeply into each of the strategies. Exhibit 11 presents the groupings of strategies and panelist assignments for each workshop.

| Exhibit 11. Working Session Strategies and Panelists | |
|--|----------------------|
| Strategies | Panelist Assignments |
| Workshop 1 | |

| Exhibit 11. Working Session Strategies and Panelists | |
|---|-------------------------------------|
| Strategies | Panelist Assignments |
| Develop mutual performance management agreements to help establish expectations with consultants/contractors. | Jeff Pelton Amanda Holland |
| Rebrand the DOT to highlight aspects that would attract a technologically savvy workforce (e.g., innovation, adoption of technology). | Jeff Pelton Amanda Holland |
| Adopt a recruitment strategy to attract women and persons of color (e.g., attend job fairs at historically Black colleges; Members of Society Advancing an Inclusive Culture within the American Society of Engineers; Diversity and Inclusion Council within the Association of General Contractors). | Jeff Pelton Amanda Holland |
| Develop career paths that link jobs in a way that integrate critical new skills (e.g., information technology, data science). | Jeff Pelton Amanda Holland |
| Workshop 2 | |
| Partnerships with local institutions. | Amit Bandyopadhyay Ryan Griffith |
| Provide leadership development opportunities for high-potential employees that build skills in key areas, including recognizing and mitigating risk, strategic thinking, planning, collaborative relationship building, and technology adaptation reviews. | Amit Bandyopadhyay Ryan Griffith |
| Construct effective teams for project work (or periodic group sessions or workshops); take a team composition approach. | Amit Bandyopadhyay Ryan Griffith |
| External “Brown Bag” Sessions with multi-modal providers (e.g., meet with scooter partner); discuss needs and learnings (i.e., networking sessions). | Amit Bandyopadhyay Ryan Griffith |
| Encourage new management policies that support flexible work options and training for managers on how to implement new policies (e.g., options for remote work, flexible work hours, flexible work location, increased autonomy). | Amit Bandyopadhyay Ryan Griffith |
| Workshop 3 | |
| Broaden applicant pool through partnerships with community and national organizations that have close networks with diverse individuals looking for jobs (e.g., DOL, local workforce board) or new entrants to the workforce (e.g., vocational schools, colleges, universities, chapters, associations). DOTs need to consider marketing jobs to other avenues and disciplines. | Jeff Pelton Christine Hetzel |

| Exhibit 11. Working Session Strategies and Panelists | |
|--|--------------------------------------|
| Strategies | Panelist Assignments |
| Retaining workforce when jobs become obsolete (develop existing employees to prepare for new roles and upskilling current workforce). | Jeff Pelton Christine Hetzel |
| Conduct cross-functional action learning projects. | Jeff Pelton Christine Hetzel |
| Create charity program that demonstrates the DOT's value for diversity and inclusion. | Jeff Pelton Christine Hetzel |
| Develop training on multi-modal designs, new technologies and systems, and resiliency plans. | Jeff Pelton Christine Hetzel |
| Workshop 4 | |
| Establish reciprocal mentoring programs between junior- and senior-level staff (make it mutually beneficial but clear on which role each participant is playing at a given time). | Christine Hetzel Ryan Griffith |
| Develop knowledge-sharing forums that address professional development needs of employees (e.g., brown bags, lunch and learns, a committee for multi-modal transportation). | Christine Hetzel Ryan Griffith |
| Revise position descriptions and specifications to match needs for specialized skill sets. | Christine Hetzel Ryan Griffith |
| Implement and require regular diversity and inclusion, tolerance, and ally training (includes a follow-up component that ensures application of what is learned). | Christine Hetzel Ryan Griffith |
| Workshop 5 | |
| Develop social media presence (highlight technologies being used; employee stories). Be intentional about what is projected; mitigated negatives/damage control. | Amanda Holland Amit Bandyopadhyay |
| Conduct assessment of workforce and workplan policies and practices to determine the level of support for diversity and inclusion (include employee pulse surveys to assess attitudinal and cultural barriers to inclusivity). | Amanda Holland Amit Bandyopadhyay |
| Develop easily accessible forums for employees to voice any concerns (e.g., town halls). | Amanda Holland Amit Bandyopadhyay |

| Exhibit 11. Working Session Strategies and Panelists | |
|---|--------------------------------------|
| Strategies | Panelist Assignments |
| Create standard operating procedures (SOPs) for collecting, maintaining, analyzing, and reporting data. Contractors can be hired to help establish an initial database, aggregate and standardize existing data, and draft SOPs; the DOT employees can then continue the process as outlined in the SOPs. | Amanda Holland Amit Bandyopadhyay |
| Create repository of information on resiliency planning to share across disciplines (could be part of a larger community of practice). | Amanda Holland Amit Bandyopadhyay |

ICF made refinements to each of the strategies based on the input from these sessions. Following the working sessions, ICF removed one of the strategies, “Create charity program that demonstrates the DOT’s value for diversity and inclusion” as it was less feasible for DOTs to implement than the other strategies.

The ICF team then created a structure for the Roadmap and produced the Guide. The Guide organized each of the strategies and action plans by whether they attract, retain, or develop staff. To ensure the Guide is user-friendly, ICF developed introductory text on how to use the Guide and best practices.

Task 9: Final Report and Presentation

ICF prepared this final report that details the methodology followed to conduct Tasks 1 through 8 and the results of these research activities and analyses. The goal of this final report was to describe ICF’s process in identifying the current industry trends and demands that will impact workforce needs for state DOTs in the future, particularly in the occupational areas of design, construction, and maintenance. Further, this final report describes how ICF created practical resources that will help state DOTs recruit, select, train, and sustain a capable workforce over the next 10+ years in light of significant labor market shifts, competitive forces, and industry changes. The final report also describes how ICF produced guidance to help unite stakeholders in building workforce capacity across the industry, especially for jobs deemed mission critical. ICF prepared the final report and submitted it to the NCHRP SPO.

In addition to the final report, ICF prepared and conducted a final briefing with the panel. In this meeting, ICF reviewed the project objectives, discussed the methodology for all tasks, and presented key findings. ICF also prepared a slide deck that overviews the information presented in the Guide. This slide deck allows state DOTs to quickly access information and help support them as they implement various strategies.

Appendices

Appendix A. Overview of Literature Review Sources and Key Findings

| Source Title | Overview and Key Findings |
|--|--|
| Workforce Needs | |
| <p>Executive Summary and National Overview: U.S. Transportation Job Needs and Priorities</p> | <p><u>Identified major challenges in the transportation workforce and 'In-Demand' occupations by region, as well as four major challenges to the transportation workforce:</u></p> <ul style="list-style-type: none"> (1) Demographic changes (especially retiring baby boomers). (2) Career awareness and recruitment. (3) New technologies and the need for operators and managers who can use them. (4) Rising demand on transportation organizations that requires a workforce with a wider range of experience. <p>The 'In-Demand' occupations included: STEM Occupations, Career and Technical Education/Vocational or Technical Occupations, Skilled Labor Occupations, Professional Occupations, and Supply Chain and Logistics Occupations.</p> |
| <p>The 2017 Wisconsin Highway Maintenance Workforce Survey</p> | <p>Collected data about highway maintenance jobs to determine:</p> <ul style="list-style-type: none"> • The number of existing jobs. • Required education. • Typical entry-level experience. • Percentage of employers struggling to fill positions. • The number of positions left unfulfilled. <p>Also collected ranked lists of skills and competencies, training requirements, sources of training, and common reasons why employees leave highway maintenance jobs.</p> |
| <p>Region V Transportation Workforce Assessment and Summit</p> | <p><u>Conducted literature review and engaged stakeholders to estimate regional workforce demand for occupations, identify Midwest region transportation goals, and provide recommendations:</u></p> <ul style="list-style-type: none"> • Found investments to promote transportation career awareness are unknown, and stakeholders should establish a common mission and performance measures. • Found most training programs did not fulfill goals because they were not credentialed or stackable. To address this, the transportation workforce should create career pathways. • The transportation industry struggles to market transportation jobs to younger generations and should reach out to schools, minorities, women, etc., with targeted messages to remove stigmas and misconceptions about transportation jobs. |

| Source Title | Overview and Key Findings |
|--|--|
| <p>Predictive Modeling of U.S. Transportation Workforce Diversity Trends: A Study of Human Capital Recruitment and Retention in Complex Environments</p> | <p><u>Studied the demographic makeup (age, gender, race, disability status, years of experience, and supervisory role) of transportation jobs and examined for differences within industry and across regions.</u> Examined for statistically significant differences only.</p> <ul style="list-style-type: none"> • Most engineering jobs are held by men. • The proportion of male to female employees in engineering jobs was associated with their race/ethnicity and year of service. • The gender disparity in engineering jobs is higher within white employees than African American employees (when controlling for region, years of service, role, and disability status). • There was no age difference across regions and roles (supervisor vs. non-supervisor). • Found female engineers tended to be younger than male engineers. |
| <p>Recruiting, Retaining, and Promoting for Careers at Transportation Agencies</p> | <p><u>Collected data and conducted interviews about difficult-to-fill jobs, jobs with high turnover, and recruiting challenges:</u></p> <ul style="list-style-type: none"> • Engineers and engineer technicians are the most difficult-to-fill jobs and have the highest turnover rates. • The biggest recruiting challenge is the wage disparity between public and private-sector jobs. <p><u>Generated a list of best practices for these struggles:</u></p> <ul style="list-style-type: none"> • Increase social media presence. • Quantification of overall benefit packages. • Implement flexible work schedules and telecommuting. • Clarify and restructure promotions and incentives. • Increase communication and feedback between staff and management. |
| <p>Strengthening Skills Training and Career Pathways Across the Transportation Industry</p> | <p><u>Examined future growth areas and employment within six transportation subsectors (trucking, transit and ground passenger, air, highway construction and maintenance, rail, and maritime transportation).</u> Also evaluated <u>high-demand jobs, patterns in required education and work experience, and on-the-job training for full competency.</u> Key findings include:</p> <ul style="list-style-type: none"> • Transportation is projected to add 417,000 jobs from 2012 to 2022 due to industry growth. • The fastest growth will occur on the West Coast, Gulf Coast, upper Mid-Atlantic, several Mountain States and Midwest; Kentucky and Vermont are expected to slightly decline. • Most job growth will be driven by increased growth in metropolitan areas. |

| Source Title | Overview and Key Findings |
|--|---|
| | <ul style="list-style-type: none"> • From 2012 to 2022, 4.2 million transportation workers will need to be hired to fill vacancies created by separations (i.e., occupational transfers, retirement). • Trucking is expected to have the largest number of job openings. • Most entry-level transportation jobs require a high school diploma, and many require training through educational programs, on-the-job training, or apprenticeships to achieve mastery. |
| <p><i>TRB Special Report 275: The Transportation Workforce Challenge - Recruiting, Training, and Retaining Qualified Workers for Transportation and Transit Agencies</i></p> | <p><u>Identified transportation workforce needs and provided recommendations to address these needs. Workforce needs include:</u></p> <ul style="list-style-type: none"> • High levels of anticipated retirements. • Insufficient numbers of mid-level managers available to fill vacancies. • Need for new workforce skills, particularly those that can address new methods and advanced technology. • Increased demand on surface transportation agencies. |
| <p>Climate Adaptation and Resiliency Planning: Agency Roles and Workforce Development Needs</p> | <p><u>Gathered survey responses to determine agency roles and workforce development needs for DOTs with climate change. Key findings below:</u></p> <ul style="list-style-type: none"> • Most agencies responded similarly, showing some consistency in needs and concerns across DOTs. • Statistical modeling found that whether an agency was preparing for a threat (e.g., natural disaster) was related to financial resources, technical tools, staffing, and agency type (state or local). • Few agencies were pursuing adaptation actions for climate change. • The biggest barriers to adaptation efforts were tools and resources, especially staff time. Both state and local agency respondents felt they were lacking resources, particularly staff. • Respondents felt needs of transportation agencies, particularly by region and organization type, needed to be clearly identified. In particular, respondents felt they needed more specific skills and qualifications communicated to them so they could better train, hire, and educate the new workforce. |
| <p>Job Priorities and Needs Report, Phase 1: Southeast Region</p> | <p><u>Identifies growing and in-demand jobs, skills needed for these jobs, and region-specific challenges for the U.S. Southeast region. Key findings include:</u></p> <ul style="list-style-type: none"> • Key industry jobs tend to be STEM, vocational or technical occupations, supply chain and logistics, and laborers. • The Southeast is unique for the influence of aerospace, aviation, distribution, and logistics. |

| Source Title | Overview and Key Findings |
|---|--|
| | <ul style="list-style-type: none"> • The Southeast’s infrastructure largely supports a strong distribution and logistics sector. • Freight volumes are expected to increase significantly in the southeast, so there is a great need for workers in the freight transportation arena. • The Southeast also has many significant military installations, allowing the transportation industry to better establish a pipeline to transportation careers. |
| <p>Job Priorities and Needs Report, Phase 1: Southwest Region</p> | <p><u>Identifies growing and in-demand jobs, skills needed for these jobs, and region-specific challenges for the U.S. Southwest region. Key findings include:</u></p> <ul style="list-style-type: none"> • The Southwest has fast-growing cities (e.g., Houston, Dallas, Los Angeles, Phoenix, etc.). • The fastest-growing industries (from 2012 to 2022; number of employees) are laborers and freight, stock and material movers, heavy and tractor-trailer truck drivers, and light truck or delivery service drivers. • Expect other careers to be in demand, like computer and information systems managers, logisticians, and financial analysts. |
| <p>Job Priorities and Needs Report, Phase 1: West Region</p> | <p><u>Identifies growing and in-demand jobs, skills needed for these jobs, and region-specific challenges for the U.S. West region. Key findings include:</u></p> <ul style="list-style-type: none"> • The West region is unique as some states have large population densities with growing pains (e.g., Washington and Hawaii), and others are large states with small populations. • Another unique feature is that the federal government owns large portions of land throughout the Western states and many of the Western states have the largest amount of American Indian land, both of which pose infrastructure and workforce challenges. • Western states have a small labor market and some of the lowest unemployment rates in the United States; further, many Western states have aging populations. • Reaching populations in Western states for recruiting and providing employment is challenging, as people are spread out and natural structures (e.g., mountains, water) prolong transportation lengths. • The largest increase (numerically) of jobs are laborers and freight, stock and material movers, heavy and tractor-trailer truck drivers, and light truck or delivery service drivers. |
| <p>Job Priorities and Needs Report, Phase 1: Northeast Region</p> | <p><u>Identifies growing and in-demand jobs, skills needed for these jobs, and region-specific challenges for the U.S. Northeast region. Key findings include:</u></p> <ul style="list-style-type: none"> • Many Northeast states are experiencing, and struggling with, an aging transportation infrastructure. |

| Source Title | Overview and Key Findings |
|--|--|
| | <ul style="list-style-type: none"> • A unique aspect of the United States is that some states rely heavily on public transportation, while other Northeastern states hardly have any. The Northeast's public transportation also varies more (bus, ferries, trains, subways, car-share and bike-share programs, etc.). • The largest increase (numerically) of jobs are computer and information systems managers and financial analysts. |
| <p>Job Priorities and Needs Report, Phase 1: Midwest Region</p> | <p><u>Identifies growing and in-demand jobs, skills needed for these jobs, and region-specific challenges for the U.S. Midwest region. Key findings include:</u></p> <ul style="list-style-type: none"> • Of all the transportation methods/systems, highways are used the most in the Midwest. • The largest increase (numerically) of jobs are heavy and tractor-trailer truck drivers, stock laborers, freight and hand material movers. |
| <p>Training and Education</p> | |
| <p>National Transportation Workforce Summit Summary of Results</p> | <p><u>Discusses training and education challenges discussed at the National Transportation Workforce Summit. Highlights include:</u></p> <ul style="list-style-type: none"> • Small applicant pool, • Attrition of current employees, and • Aging workforce. <p><u>Proposed solutions include:</u></p> <ul style="list-style-type: none"> • Building and raising career awareness (e.g., reaching out to high school and college students, increasing interest and training for second careers in transportation, and improving preparation for public transit and railroad occupations). • Transitioning from the classroom to the workplace (e.g., match curriculums with transportation industry needs; increase transportation degree, credit, and skill portability; expand workforce access to post-secondary education; improve student readiness for transportation workforce). • Continuing education and retaining transportation workforce (e.g., increase workforce retention in underserved populations, accommodate aging and multi-generational workforce, increase resiliency of the workforce, adapt to technological advances, and increase workforce data reliability and accessibility). |

| Source Title | Overview and Key Findings |
|---|--|
| <p><i>NCHRP Synthesis 362: Training Programs, Processes, Policies, and Practices</i></p> | <p><u>Synthesis of training programs, processes, policies, and practices using existing literature and interviews with state DOTs.</u></p> <ul style="list-style-type: none"> • Found many state DOT training departments understand their workforce needs the competencies to produce the products, goods, and services required, but most lack mechanisms to assess the presence or absence of these competencies in their current workforce. • These state DOTs also have evaluation methods to assess training programs and learning but many do not link evaluation results with funding requests or funding distributions, resulting in their most critical needs not being met. • Many state DOTs lack strategic alignment. • Overall, it seems that state DOTs have a solid base but need strong executive leadership and attention to ensure they are aligned and properly building upward. |
| <p>Effectiveness Assessment of Transportation Cost Estimation and Cost Management Workforce Educational Training for Complex Problems</p> | <p><u>Provides a method for accurately estimating costs of transportation projects and conducts two pilot studies (Texas and Maryland DOTs) using this method.</u></p> |
| <p>Developing an Interdisciplinary Transportation Certificate Program for Today’s Transportation Workforce</p> | <p><u>Case study of Texas A&M University's (distance learning) interdisciplinary transportation certificate program.</u></p> <ul style="list-style-type: none"> • Discusses curriculum development, certificate implementation, and marketing and recruiting efforts. |
| <p><i>TCRP Research Report 199: Transit Technical Training, Volume 1: Guide to Applying Best Practices and Sharing Resources</i></p> | <p><u>Presents innovative training methods and best practices for training a variety of DOT jobs.</u></p> <ul style="list-style-type: none"> • Trainings are thorough, including detailed examples for many occupations within DOTs. |

| Source Title | Overview and Key Findings |
|---|---|
| <p><i>TCRP Research Report 199: Transit Technical Training, Volume 2: Guide to Overcoming Barriers to Implementing Best and Innovative Training</i></p> | <p><u>Presents challenges and best practices when training frontline employees and implementing new and innovative trainings. Guide's focus areas include:</u></p> <ul style="list-style-type: none"> • Understanding training needs and learning tendencies. • Infrastructure, equipment, and lost productivity costs. • Capacity for training and instructor evaluation. • Access to innovative training technology. • Awareness of available shared-training resources and courses. • Training content is outdated. • Training not aligned with needs. • Legal risks of shared-training models. • Lack of adequate resources. |
| <p><i>NCHRP Synthesis: Training and Certification of Highway Maintenance Workers</i></p> | <p><u>Examined U.S. and Canada transit organizations and how they trained/educated their maintenance workers. Key findings include:</u></p> <ul style="list-style-type: none"> • Preferred methods of training are instructor-led training, on-the-job training, or a combination of the two; web-based trainings are becoming more popular though. • Most transit organizations do not use incentives to encourage training participation. • Organizations that use incentives often use promotional opportunities and incentives that deal with skill development. • Most organizations reported their maintenance training is aligned with performance requirements, and employees reported supervisors encouraged trainings. • Few organizations examine the success of their trainings. If organizations evaluated training, it was often restricted to perceptions (e.g., was it helpful?). • Almost all organizations develop trainings in-house, and the most common area trained was "general maintenance skills." |
| <p><i>Developing and Maintaining Construction Inspection Competence</i> (NCHRP Project 20-68A, Scan 15-01)</p> | <p><u>Report that gathered information from state DOTs about the challenges of developing and maintaining their construction workforce. Key findings about successful trainings include:</u></p> <ul style="list-style-type: none"> • Key elements of success (i.e., competence) for construction workers include mentoring, formal training programs, using qualified CEI personnel, accepting regional and national certifications, and upholding hiring and staffing practices. • No state DOT uses all of the key elements above; they use varying combinations of these elements. |

| Source Title | Overview and Key Findings |
|--|---|
| <i>NCHRP Synthesis 528: Analyzing Data for Measuring Transportation Performance by State DOTs and MPOs</i> | <p><u>Report examining what data state DOTs gather, whether they need more, and how prepared their workforce is for collecting and integrating this data. Key findings relevant to training and education include:</u></p> <ul style="list-style-type: none"> • State DOTs felt their staff need to increase proficiency in assessing mobility, bridge, pavement, and safety data. |
| Building an Apprenticeship and Training System for Maintenance Occupations in the American Transit Industry | <p><u>Examines the prevalence of using apprenticeships for transit maintenance jobs and successes of other, similar occupations that use apprenticeships.</u></p> <ul style="list-style-type: none"> • Found U.S. transit maintenance jobs do not use apprenticeships often, and the authors provide extensive reasoning why an apprenticeship model makes sense for this industry. • Provides background on the general prevalence and success of using apprenticeships. |
| Technological Advances | |
| <i>NCHRP Synthesis 503: Leveraging Technology for Transportation Agency Workforce Development and Training</i> | <p><u>Examined how DOTs use technology within trainings. Key findings include:</u></p> <ul style="list-style-type: none"> • State DOTs use information and communication technologies (ICT) to deliver training. • Most DOTs combine traditional, in-class training with ICT training. • State DOTs use ICT for trainings because it addresses many constraints (e.g., reduces time spent in class, offers more flexibility, and allows for individualized learning). • Most state DOTs that use ICTs use web-based and computer-based trainings. |
| <i>NCHRP Report 768: Guide to Accelerating New Technology Adoption through Directed Technology Transfer</i> | <p><u>Guide for how transit organizations can establish well-planned and systematic technology transfer (i.e., technology or ideas being transferred to solve a problem or gain an advantage).</u></p> <ul style="list-style-type: none"> • Useful for teaching DOTs how to share knowledge (relevant to technological advances or implementations) with each other. |
| The Promises and Risks of Innovation (<i>TR News 307</i>) | <p><u>Article about the positives and challenges with technological advancements. Article highlights include:</u></p> <ul style="list-style-type: none"> • Legal and structural changes with automated vehicles (especially for maintenance jobs). • Legal challenges and varying regulations for red-light cameras, unmanned aerial systems, and ridesharing services. • Increased focus on being environmentally sustainable—recycling roads for example. • Improved freight data due to increased technology. |
| <i>NCHRP Web-Only Document 239: Impacts of Laws and Regulations on CV and AV</i> | <p><u>Examines possible automated vehicle technology deployment scenarios for public transit, safety assurance considerations with blending automotive methodologies, workforce deployment, policy changes, and government laws and regulations.</u></p> |

| Source Title | Overview and Key Findings |
|---|---|
| <i>Technology Introduction in Transit Operations</i> | |
| Developing the Workforce for a Connected Vehicle Future: USDOT's Intelligent Transportation Systems Training Opportunities for Today and Tomorrow | <p><u>Reviews how technology is changing the DOT and what current trainings DOT has to prepare their workforce for these technological advances.</u></p> <ul style="list-style-type: none"> • Transportation workforce will need to become more skilled with technology as vehicles will generate large quantities of data, communicate with each other, etc., and greatly change the demands of the DOT. • DOT has several trainings to prepare its workforce for technological advances. |
| Policies and Regulation | |
| Changing Workforce Development Needs for Regional Transportation Planning Agencies in California | <p><u>Conducted online surveys, job scans, and interviews with Councils of Government (COG) and Metropolitan Planning Agencies (MPOs) to determine workforce needs. Findings include:</u></p> <ul style="list-style-type: none"> • Regional DOTs need more expertise for complying with new legislative mandates, especially SB 375. • There is a need for employees to have a combination of technical and soft skills, as employees will need to effectively change the nature, process, and delivery of sustainable transportation projects because of SB 375. • MPOs have increased responsibility without the necessary means to meet these demands, because of SB 375. |
| Integration with Contractors | |
| <i>NCHRP Research Report 867: Keeping What You Paid For—Retaining Essential Consultant-Developed Knowledge Within DOTs</i> | <p>Guide for helping DOTs identify and implement strategies for knowledge exchange between the DOT, consultants, and contractors.</p> |
| <i>NCHRP Web-Only Document 238: Developing the Guide to Retaining Essential Consultant-Developed Knowledge Within DOTs</i> | <p><u>Studied feelings toward consultants and the transfer of knowledge and advice from consultant to DOT:</u></p> <ul style="list-style-type: none"> • Most DOT managers did not care about losing knowledge from consultants because most consulting projects are routine. • Managers felt comfortable reaching out to consultants with questions. • Managers felt the consultants' documentation was thorough, and some consultants' work is highly specialized and unique and does not need to be transferred. |

| Source Title | Overview and Key Findings |
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| Alternative Contracting Methods Research | <p><u>Reviewed alternative contracting methods (ACMs). Key points include:</u></p> <ul style="list-style-type: none"> • ACMs require extensive contractor engagement to properly design/solve projects. • ACMs are common in design-build and construction manager-general roles. • Research suggests ACMs, particularly design-build ACMs, are more effective at controlling cost and scheduling growth than traditional design-bid-build methods. • ACM projects are delivered 35% faster than traditional methods across the transportation industry and have higher performance on federal highway projects. |
| Effective Tools for Projects Delivered by Construction Manager-General Contractor Method | <p><u>Synthesizes best practices for using Construction Manager/General Contractor (CM/GC) as a project delivery method.</u></p> <ul style="list-style-type: none"> • The two most important aspects of CM/GC relationships are jointly managing risk and developing a collaborative climate |
| Does Design-Build Project Delivery Affect the Future of the Public Engineer? <i>(Transportation Research Record: Journal of the Transportation Research Board. No. 2081).</i> | <p><u>Collected responses from 43 states and territories to examine the use of design-build projects (a type of contracting), effectiveness, and effects it has on DOTs and engineers. Key findings include:</u></p> <ul style="list-style-type: none"> • Design-build is a good project delivery tool for highways and infrastructure; once considered to be experimental, it has demonstrated its effectiveness over time and is a tried and tested method now. • The research indicates design-build projects will not eliminate jobs for public agency professional engineers, despite being a concern for many public agency engineers. • To have the most success with a design-build project, there needs to be a well-qualified, competent staff at the agency too. |
| <i>NCHRP Report 787: Guide for Design Management on Design-Build and Construction Manager/General Contractor Projects</i> | <p><u>Guide and case studies for managing Design-Build and Construction Manager/General Contractor (CM/GC) contracting projects: Findings include:</u></p> <ul style="list-style-type: none"> • Transportation agency employees feel they lack control over the design process when using the Design-Build delivery system. • Construction-Manager-at-Risk delivery system allows for a better contractual relationship; however, it is less popular than Design-Build because contractors do not like not performing the work themselves. • CM/GC is modeled after Construction-Manager-at-Risk but allows the construction manager to perform some of the work. • Today, Design-Build and CM/CG are popular for delivering transportation projects. |
| Resources, Tools, and Practices | |

| Source Title | Overview and Key Findings |
|---|--|
| <p><i>NCHRP Synthesis 509: Highway Worker Safety: A Synthesis of Highway Practice</i></p> | <p><u>Overview of state DOT highway safety practices for employees and identifies next steps/future directions for improving highway safety for workers.</u></p> <ul style="list-style-type: none"> • DOTs need to learn the risk factors for highway safety and how to better integrate highway safety data. • All state DOTs have different safety practices as every state has different safety challenges/concerns and limitations. |
| <p><i>TCRP Research Report 194: Knowledge Management Resource to Support Strategic Workforce Development for Transit Agencies</i></p> | <p><u>Guides transit agencies through knowledge management (KM), which is the process of collecting and managing organizational knowledge and information.</u></p> <ul style="list-style-type: none"> • KM can be a risk-management strategy, an enabler for business success, can result in faster decision-making, and can produce increased efficiency. |
| <p><i>SHRP2 Report S2-R03-RR-2: Guide to Identifying and Reducing Workforce Fatigue in Rapid Renewal Projects</i></p> | <p><u>Provides best practices for reducing workforce fatigue. These include:</u></p> <ul style="list-style-type: none"> • Increase awareness of the importance of workplace fatigue within DOTs. • Assess risk factors for specific projects and jobs where fatigue may be less or more common. • Educate workers and managers about the nature of sleep loss, circadian rhythm, fatigue, and approaches for reducing fatigue. • Establish methods for monitoring and assessing risk factors related to workplace fatigue. • Determine the most effective methods to reduce fatigue on a job- and project-specific basis (report provides several methods and implementation processes for these methods). • Important because many transportation jobs require long hours, nontraditional shifts, and manual labor. Better addressing worker fatigue can help not only employee safety but also improve job engagement. |

| Source Title | Overview and Key Findings |
|--|--|
| <p>2015 HireRight Transportation Survey Uncovers Motor Carriers' Recruiting, Retention, and Screening Strategies to Address Ever-Growing Driver Shortage</p> | <p style="text-align: center;">Recruit, Retain, and Engage</p> <p><u>Article overviewing motor carriers (i.e., companies that hire truck drivers) who have successfully increased employees via recruiting and retaining. Identified strategies that worked include:</u></p> <ul style="list-style-type: none"> • To recruit more drivers, motor carriers are offering generous sign-on bonuses and payouts (after a period of time) and conducting truck driver school recruitment programs (in addition to referrals, online job boards, and print media). • Some organizations even hire drivers before they finished instruction and pay for their tuition. • To increase diversity among truck drivers, organizations are purposefully recruiting diverse populations (e.g., women, minorities, immigrants), and some truck manufacturers are designing trucks, especially for women. <p><u>To increase retention, companies have:</u></p> <ul style="list-style-type: none"> • Increased pay. • Upgraded equipment. • Offered performance-based bonuses. • Created recognition/reward programs. • Held driver appreciation events. • Offered flexible work arrangements (more common with small carriers). • Provided stable income (have a set route, provide guaranteed income during contract periods, etc.). <p>Companies have also increased their applicants' screening, helping them better hire people who meet requirements and will drive safely.</p> |
| <p>Employee Engagement, Boredom, and Frontline Construction Workers Feeling Safe in Their Workplace</p> | <p><u>Study (surveys and focus groups) with Australian frontline construction workers to examine influences of engagement and safety. Key findings include:</u></p> <ul style="list-style-type: none"> • Regular shift changes and other job site workers being fatigued influence perceptions of safety. • Group dynamics and energy can greatly impact safety perceptions and boredom (i.e., employees rub off on each other); managers should be aware of their team's energy and address negative dynamics. • Employees being fatigued is a significant safety concern. |

| Source Title | Overview and Key Findings |
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| | <ul style="list-style-type: none"> • Most managers wait for a safety incident or a lost-time incident to update and enhance worker engagement; this should be stopped, and managers should work on employee engagement regularly. • The bullet above is particularly important, too, as employee boredom is also a predictor of safety incidents. If managers better engage employees, they may be able to prevent more safety incidents. • By addressing boredom and negative team culture, the researchers also found small improvements in worker safety perceptions and improved employee engagement and productivity. |
| <p><i>NCHRP Synthesis 538: Practices for Online Public Involvement</i></p> | <p><u>Conducted interviews and administered surveys to understand DOTs' current and desired online public involvement (OPI). Key findings included:</u></p> <ul style="list-style-type: none"> • DOTs have demand for and want better OPI. There is internal support (e.g., managers, higher leadership) for implementing OPI. • Most DOTs have formal policies and procedures for OPI behavior (e.g., what to post, how to respond, etc.). • Websites and social media are the most common types of OPI. Other types include electronic surveys, informational videos, and digital newsletters. • OPI challenges include limited internet access for users, staff inexperience, and budget constraints. • Most DOTs have specific staff for operating OPI. • Most DOTs gather extensive feedback through OPI, but few know how to properly consolidate it. • Several DOTs have no OPI, citing lack of staff knowledge/training, the inability to meet federal and state requirements for public involvement, and experiencing technical issues. |

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| <p><i>NCHRP Report 685: Strategies to Attract and Retain a Capable Transportation Workforce</i></p> | <p><u>Identified several workforce challenges within the transportation industry. These include:</u></p> <ul style="list-style-type: none"> • Lack of planning (e.g., lack of recruiting process, failure to adequately brand the industry). • Difficult work context (e.g., manual, outdoor labor; geographic challenges; lack of flexibility and autonomy; and bureaucratic hiring policies). • Evolving workforce trends (e.g., lack of skilled applicants, aging workers, and technology). • Influx of younger workers (e.g., different career decision-making, high expectations of an employer, lack of learning opportunities), strong competition (aggressive recruiting, failure to invest in talent pipeline). • Leadership issues. • Misperception of industry. • Applicant issues (e.g., impact of employees with children, difficulty finding applicants with in-demand skills). • Difficulty ensuring continuity of organizational resources. • Demanding work environment. • Evolving workforce structures. • Generational issues. • Tough competition from related industries. • Training issues. <p><u>With these challenges, proposed possible solutions include:</u></p> <ul style="list-style-type: none"> • Develop future applicant skills (e.g., develop internship/fellowship programs, sponsor scholarships). • Increase the number of applicants (e.g., host career days, tailor advertising efforts, harness technology, consider nontraditional hires). • Screen applicants (e.g., use multiple interviewers, integrate human resources in the hiring process, screen for eligibility, competency, and fit). • Promote existing staff (e.g., recruit existing employees, create job rotation program, develop a staffing plan). • Brand the organization/industry (e.g., advertise strengths of the organization, get involved in the community, use a comprehensive marketing campaign). • Reduce voluntary turnover (e.g., reward citizenship behaviors, remove obstacles to employee growth). |
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| Source Title | Overview and Key Findings |
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| | <ul style="list-style-type: none"> • Anticipate and manage performance issues (e.g., provide meaningful performance feedback, mentor and coach employees). • Develop internal staff skills (e.g., offer off-site and higher education training opportunities, use technology to support training). • Improve culture/climate (e.g., engage the community, survey and interview employees). • Develop leaders (e.g., provide leadership training, emphasize follower development in leadership training, and mentor and coach leaders). • Classify and design jobs (create dual career tracks for managers, emphasize job enrichment). • Succession planning (e.g., implement succession planning program and establish diversity goals). • Develop knowledge management systems (create people-focused knowledge management systems). • Restructure benefits and compensation (e.g., research competitive compensation and supplement alternative benefits packages). • Promote work-life balance (e.g., improve work schedules, allow flexible schedules and telework). |
| <p>Attracting and Retaining Women in the Transportation Industry</p> | <p><u>Report details major findings of research in attracting, promoting, and retaining women in transportation.</u></p> <ul style="list-style-type: none"> • Found men are more attracted to agentic goals, while women are attracted to communal goals. • Argued the misalignment of goals (between the organization and individual) and lack of female role models are the main reasons why women tend to avoid the transportation industry. |
| <p><i>NCHRP Report 685: Guide to Attract and Retain a Capable Transportation Workforce</i></p> | <p><u>A guide for human resources managers and hiring professionals to use so they can improve recruitment and retention strategies in their transportation organizations.</u></p> <ul style="list-style-type: none"> • Provides thorough strategies for better recruiting and retaining employees in transportation industries. • Useful sample guide. |

Appendix B. Task 2 Focus Group and Interview Protocol Questions

Focus Group Protocol

Introduction

Welcome and thank you for participating in this focus group. My name is [facilitator name], and I represent ICF, the consulting firm selected by Transportation Research Board's National Cooperative Highway Research Program to conduct a project to help DOTs identify challenges and then effective strategies for building a sustainable highway design, construction, and maintenance workforce. We also have [recorder name] on the line who will be taking notes on our conversation so that we are able to best provide all your opinions and experiences back to NCHRP.

Project Overview

To help conduct this study, ICF will be gathering data via interviews and focus groups. Your insights shared during this focus group will help us to learn about future needs and best practices for the design, construction, and maintenance workforce. We also believe that your participation will provide value to you in that you will have the opportunity to learn from other highway professionals about workforce challenges that they are facing. For your participation, we will feature and thank you in the published project report. We know your time is valuable and greatly appreciate you being here today.

Confidentiality Statement

All data collected from the focus group today will be aggregated with data from other focus groups. Each comment reported will be non-attributional in that personal identifying information will be removed from the individual comments before the comments are presented outside our ICF research team. All personal identifying information we collect today will be used for record-keeping purposes and not to track specific responses. We also ask that each participant respect the confidentiality of other participants and not disclose any information shared today with anyone outside this room.

We will, however, identify you in the report as participating in data collection to provide recognition and thank you for your time and effort in participating. Your name will simply be presented in a table of participants, not next to any specific comment. If you prefer not to be recognized in our final report, please let us know after the session.

To help us ensure we accurately capture your data, we plan to audio record today's session. No individual identifiers will be included in the data, and the recording will only be used as a backup if needed. Are there any objections to being recorded?

Ground Rules

Given the short timeframe we have to collect a large amount of data today, I ask that you follow some simple ground rules to help keep us all on track.

- Be respectful of others' opinions; there are no right or wrong answers since all answers are based on personal experience or opinions.

- Please do not interrupt one another. One person should speak at a time. This is important so we can capture each of your thoughts in our notes.
- Please state your answer as concisely as possible so that we have time to hear from multiple people on each question.
- Please stay on topic. Please provide answers that are relevant to the question asked.
- Be understanding of the facilitator's role. At times, I may need to interrupt someone to move to a new question or to allow another participant to speak. This will help keep us on track and ensure we cover all of the questions presented within the time allowed. If you have additional information you want to share but time does not permit us to discuss it, please feel free to email me.
- Please stay engaged in the discussion. Please be prepared that we may call on participants by name as needed to give everyone a chance to speak and keep the conversation flowing.
- Any "ground rules" you would like to add?

Any questions before we get started? If not, then let's proceed.

1. Introductions

1. Please introduce yourself and provide a brief overview of your background and current role.
 - a. How long have you worked in transportation? (Note: If asked, we are referring to highways/state DOT vs. other modes of transportation.)
 - b. How long have you worked for the organization you work for now?
 - c. What is your job title? How long have you been in that role?
 - d. What motivated you to first take a job in transportation? What *keeps* you working in transportation?

2. Understanding Workforce Needs

2. The focus of this effort is to help agencies better prepare to meet the construction, maintenance, and design workforce needs of the future (into 2030).
 - a. What new industry-wide trends and changes facing DOTs are likely to impact jobs in these occupational areas (e.g., financial changes, public demands, population growth/decline, technology)?
 - b. What are some of the challenges your agency is currently facing in building a strong, skilled workforce in each of these fields: design, construction, and maintenance?

3. Impact on Specific Jobs

3. How do you think the knowledge, skill, and ability requirements for the [construction/maintenance/design] workforce will evolve in the near future?
 - a. What are the major factors impacting these anticipated changes?
4. What jobs are most affected by current skill gaps? Which transportation jobs are likely to deal with the greatest skill deficits in the next 10 years?

4. Building a Workforce Pipeline

5. How can your agency—and the industry as a whole—best prepare to meet those future talent needs in design, construction, and maintenance?
 - a. What do you think the biggest challenges will be?
 - b. What are you currently doing to deal with these challenges?
6. What recommendations do you have to ensure there is a sufficient pipeline of future talent across the transportation industry?
 - a. How can education and training programs better support the needs of DOTs?

5. Industry Support

7. What external partnerships (across industry) play an important role in helping DOTs cultivate a strong construction, maintenance, and design workforce?
 - a. What partnerships have your agency found to be particularly valuable for addressing your workforce needs?
8. How can the industry (e.g., associations, trade institutions, labor unions, workforce centers, AASHTO, TRB, FHWA) help your agency better meet its current and future needs related to the construction, maintenance, and design workforce?
 - a. What are some ways that these industries are currently helping you?
 - b. What kind of industry support do you currently leverage?
 - c. What are the benefits and challenges involved in leveraging that support?
9. Do you have any final comments that you would like to provide?
10. Would you be willing to participate in a follow-up interview to further discuss some of the strategies we identify during the course of this project effort?

Thank you for your participation!

Interview Protocol

Introduction

Welcome and thank you for participating in this interview. My name is [facilitator name], and I represent ICF, the consulting firm selected by Transportation Research Board's National Cooperative Highway Research Program to conduct a project to help DOTs identify challenges and then effective strategies for building a sustainable highway design, construction, and maintenance workforce. We also have [recorder name] on the line who will be taking notes on our conversation so that we are able to best provide all your opinions and experiences back to NCHRP.

Project Overview

To help conduct this study, ICF has been gathering data via interviews and focus groups. Your insights shared during this interview will help us learn about future needs and best practices for the design, construction, and maintenance workforce. For your participation, we will feature and thank you in the published project report. We know your time is valuable and greatly appreciate you being here today.

Confidentiality Statement

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 - c. What is your job title? How long have you been in that role?
 - d. What motivated you to first take a job in transportation? What *keeps* you working in transportation?

2. Agency Structural Considerations

As mentioned, this study is predominantly focused on construction, maintenance, and design functions within DOTs, and the way in which the nature of work is changing industry-wide.

Let's transition to talking a bit about how those occupational areas currently exist and are evolving within your agency.

2. Where do the construction, maintenance, and design functions fit within the structure of your agency?
 - a. What are the benefits or challenges associated with that structure?
3. Please describe the extent to which contractors are used within your agency to support the design, construction, and maintenance workforce.
 - a. What percentage are employees versus contractors?
 - b. How well is this mix working for the agency? What challenges have you encountered?
4. Would you say that your agency has a diverse workforce? Why or why not?
 - a. What do you think the biggest challenges are to recruiting and maintaining a diverse workforce in these occupational areas?
5. Are there any policies that exist—within your organization or otherwise—that inhibit the ability of the construction, maintenance, and design workforce to do their jobs effectively? If so, what are they?
 - a. If you had the power to change these policies, what changes would you make?
6. What role does technology play in design, construction, and maintenance within your agency? How do you expect that to change over the next 10 years? How well prepared will your workforce be to adapt to these new technologies?
7. Overall, to what extent do you think your agency is prepared to meet current and future needs related to the construction, maintenance, and design workforce?
 - a. What are your agency's biggest strengths?
 - b. What are your agency's biggest weaknesses?

3. Human Capital Strategies

8. What are the biggest obstacles to attracting, retaining, and developing qualified employees for the [construction/maintenance/design] workforce?
9. Please describe any innovative or effective practices your agency has put into place to attract qualified workers.
10. Please describe any innovative or effective practices your agency has employed to train and develop employees to serve in design, construction, and maintenance roles.
11. Please describe any innovative or effective practices your agency has employed to retain qualified employees.

4. Job Titles

12. We have created a draft list of construction, maintenance, and design jobs (**see following page**). After reviewing this list, what jobs or types of jobs are missing that you see in your agency?
 - a. Where do these jobs fit within the organization?
 - b. Are they similar to jobs that are already listed here? If so, could they be considered the same job, just with a different title?

Construction:

Bridge Inspection Crane Technician
 Bridge Inspection Crane Technician Supervisor
 Civil Engineer
 Diesel and Construction Equipment Mechanic
 Drill Operator
 Electrician
 Environmental Specialist
 Equipment Body Repairer
 Equipment Operator
 Excavating and Loading Machine and Dragline Operator
 Highway Sign Worker
 Highway Equipment Manager
 Highway Foreman
 Mason
 Materials Engineer
 Materials Manager
 Materials Supervisor
 Materials Technician
 Paving, Surfacing, and Tamping Equipment Operator
 Photogrammetry Technician
 Roadside Manager
 Roadside Specialist
 Roadside Specialist Supervisor
 Roadside Technician
 Roadway Programs Coordinator
 Roadway Programs Manager
 Roadway Programs Specialist
 Roadway Programs Technician
 Roadway Programs Technician Supervisor
 Sign Technician
 Surveyor
 Traffic Control Technician
 Traffic Management Operator
 Traffic Systems Control Specialist
 Transportation Construction Inspector
 Transportation Construction Manager

Transportation Equipment Operator
 Transportation Equipment Operator Instructor
 Transportation Equipment Operator Specialist
 Transportation Equipment Operator Trainee
 Transportation Technician
 Utility Relocation Technician
 Welder

Maintenance:

Assistant Highway Maintenance Manager
 Civil Engineer
 Highway Equipment Manager
 Highway Foreman
 Highway Maintenance Technician
 Highway Maintenance Worker
 Highway Maintenance Coordinator
 Highway Sign Worker
 Historic Preservation Specialist
 Maintenance Repairman
 Materials Engineer
 Materials Manager
 Materials Supervisor
 Materials Technician
 Roadside Manager
 Roadside Specialist
 Roadside Specialist Supervisor
 Roadside Technician
 Roadway Programs Coordinator
 Roadway Programs Manager
 Roadway Programs Specialist
 Roadway Programs Technician
 Roadway Programs Technician Supervisor
 Transportation Equipment Operator
 Transportation Equipment Operator Instructor
 Transportation Equipment Operator Specialist
 Transportation Equipment Operator Trainee

Transportation Maintenance Specialist
 Transportation Technician
 Tunnel Maintainer
 Tunnel Maintainer Supervisor

Design:

Architectural Designer
 Bridge and Structural Design Manager
 Bridge and Structural Design Supervisor
 Bridge and Structural Designer
 Bridge and Structural Drafter
 Bridge and Structural Draftsman Designer
 Cartographic Drafter
 Civil Drafter
 Civil Engineer
 Highway Design Manager
 Highway Design Supervisor
 Highway Designer
 Highway Drafter
 Highway Draftsman Designer
 Lithographic Press Operator
 Roadway Designer
 Roadway Engineer
 Traffic Engineer
 Transportation Engineer
 Transportation Planner

13. Next, we will discuss each of the occupational groupings to learn more about the included jobs and their requirements. What are the job requirements for these types of positions?
- a. What role do these jobs play in achieving the day-to-day objectives required for the agency?
 - b. What are the unique functions of these jobs?
 - c. What would the impact of these jobs, if not filled, be on DOT operations?

Thank you for your participation!

Appendix C: Task 2 Focus Group Participant List

| | |
|---------------------------|------------------------|
| Adams, Clay | Lund, Steve M. |
| Alexander, Ebony | Ma, Jianming |
| Bahr Worley, Kandee | Martin, Alexis |
| Bakotich, Pasco | McGill, Galen |
| Barry, Ed | Mighdoll, Bradley |
| Bellgowan, Matt | Millikan, Ian |
| Berends, Terry | Milton, John |
| Braceras, Carlos | Morrison, Bill |
| Buchholz, Tom | Nebergall, MaryLou |
| Bush, Anita | Olson, Heidi L |
| Cecilia McNeil-Hardwick | Pappas, Jim |
| Chase, Wayne | Peters, Jake |
| Christine Miller | Peterson, Kris Terry |
| Christopher, Chris | Phillips, Dana |
| Clark Martin | Phillips, Elizabeth W |
| Cowan, Troy | Pittman, James Richard |
| Darr, Brad W. | Raboy, Kelli |
| Daubenberger, Nancy | Roark, Steve |
| Deffenbacher, Jon | Robinson, Brian J |
| Dobbins, Caleb B. | Roy, Chris |
| Duncan, Monica | Sanders, Tina |
| Elizer, R. Marshall | Schneider, Paul F |
| Fleming, Mike | Schueler, JoAnn |
| Flowers, Ramono | Schuster, Kristin |
| Fulton, Blake | Stertz, David L |
| Gainesm, Mark | Stewart, Robert |
| Griffith, Ryan | Suing, Troy |
| Hammit, Dallas | Terry, Jeff |
| Hatcher, Jerry | Thayer, Scott |
| Hendrickson, Andrea | Thelen, Amber |
| Henion, Greg | Tucker, Michelle Ann |
| Henning, David | Voss, Kenneth L |
| Hibbard, John Len | Waechter, Geri |
| Holland, Amanda R | White, Megan |
| Hunnicut, Christine Prevo | Williams, Brenda |
| Jaime Waller | Wohlberg, Bonnie |
| Kelley, Joseph | Woods, Crystal |
| Kennerly, Michael J. | Woods, Mark E |
| Kratofil, Tony | Young, Christopher |
| Lagerberg, Brian | Zamora, Laura E |
| Larson, Larry | |
| Leaphart, Andrew | |
| Lidder, Mylin | |
| Little, Lauren | |
| Lori Lange | |

Appendix D. Overview of Task 2 Major Findings and State DOT Practices

I. Introduction

State departments of transportation (DOTs) operate in a world that looks much different than it did in the 20th century when many of America's highways and bridges were first constructed. Technological advancements, economic changes, and other large shifts in society are rapidly redefining how the transportation industry functions and are presenting new challenges to maintaining a strong design, construction, and maintenance workforce. As state DOTs look forward to the year 2030 and beyond, they must think strategically about how to best position themselves to address the challenges stemming from these industry-wide trends.

ICF explored this topic by conducting 32 focus groups and stakeholder interviews over the span of 4 weeks, speaking with 85 transportation professionals from 31 different states. Below is a summary of the major findings.

II. Industry-Wide Trends and the Changing Nature of Work

Participants described their organizations adopting emerging technology such as 3D modeling and geographic information systems (GIS), while others commented that smartphones and tablets are beginning to replace charts and clipboards in the hands of their construction and maintenance staff in the field. Snowplow operators in Minnesota are now using in-cab computer systems to track the weather and provide decision support, and inspectors in Washington State are using drones to inspect bridges. These examples demonstrate that state DOTs are adopting new technology to expand the capabilities of their design, construction, and maintenance workforce. Another trend that shined through during these interviews was an increased emphasis on data science and statistical analysis as they relate to the data produced by these new systems. State DOTs across the country are finding themselves doing more and more data analysis as part of the job and often struggling to find staff capable to do so.

A number of long-tenured DOT professionals who were interviewed described taking their first job in the public sector in part because it offered a stable paycheck during a time when the national economy was stagnant. These participants drew a contrast between then and now, with today's economy booming and competition for workers as fierce as it has been in years. The fact that state DOTs are facing stiff competition from the private sector came up in nearly every focus group and interview. The most common complaint was that they are consistently unable to compete on compensation, causing difficulty recruiting and retaining good employees. This is a prevalent challenge across the design, construction, and maintenance functional areas.

Another trend that appeared frequently during these focus groups and interviews was that state DOTs feel financially constrained by seemingly perpetual budget uncertainty. As one transportation professional put it, funding "is always a question" when it comes to design, construction, and maintenance work, which ultimately has a negative impact on the workforce. This financial reality is only compounded by the renewed focus on our country's aging infrastructure. Politicians and experts are guiding public attention to the fact that the highways, bridges, and structures built 50 to 100 years ago desperately need repair. Several participants said they were concerned with the ability of their departments to respond to these growing calls with

the financial resources currently available to them and admitted they will need to increase their reliance on contractors to get this work done.

The rise of multi-modal transportation (bikes, scooters, pedestrians, public transit, etc.) is another trend state DOTs are noticing, particularly in the urban areas where they operate. The increasing popularity of these forms of transportation is requiring designers and construction workers to think differently about how roadways are designed and built. This trend will likely continue as climate change causes the public to consider choosing alternative modes of transportation over the automobile. Advances in the development of autonomous vehicles and the additional work required to accommodate this new technology on existing roadways are other changes that concern participants.

III. Human Capital Challenges

Each participant outlined challenges their department faces as well as challenges facing the entire transportation industry. The discussed challenges fall under three distinct categories: recruitment and branding, retention and knowledge management, and workforce development. DOTs must understand and work through these challenges to build and maintain a strong design, construction, and maintenance workforce.

Recruitment and Branding Challenges

Challenges in recruitment and branding have made it difficult for departments to attract and retain a viable workforce. The stigma of blue-collar jobs has made it difficult to convince people that jobs in maintenance and construction can be just as desirable as white-collar jobs requiring a college degree. Not only is the stigma of transportation jobs affecting recruitment, but slow hiring practices are preventing departments from recruiting qualified candidates. Multiple participants mentioned that their hiring process is much slower than their private competitors, and interested candidates are hired elsewhere. Private contractors have the upper hand on public agencies when it comes to certain required certificates. Qualified employees with a commercial driver's license and a PEL are more attracted to private companies and contractors due to the financial gain. This high competition for the same group of employees has made it difficult to recruit qualified employees to maintain a workforce. The state of the economy also brings competition between public and private agencies. Government jobs offer financial stability in a bad economy but are less attractive when the economy is booming. A good economy translates to DOTs struggling to recruit and retain.

Another trend that has brought unique challenges to transportation departments is the popularity and expectation of flexible workplace policies, including flexible work hours and telework. This strays away from the traditional workplace culture that has been seen in transportation departments for decades. DOTs are not used to offering flexible work schedules, and many DOTs lack the infrastructure to do so. For many agencies, it is not possible to offer flexible work benefits to maintenance and construction workers because of the nature of that work. It is also difficult to convince managers and supervisors of this new trend.

Retention and Knowledge Management Challenges

Transportation departments have also seen a shift in retention and knowledge management that has brought its own unique set of challenges. As discussed earlier, the adoption of new technologies has brought many challenges that put a strain on sustaining a comprehensive workforce. A major challenge with new technologies is the learning curve with older generation workers. Departments are struggling to build an appetite and capacity to use these new technologies. As technology becomes more complex, there is a greater need to respond to technological advancements. There has also been an increased reliance on data science and statistical analysis with the adoption of new technologies. Agencies have found it challenging to build staff capacity to work within these disciplines. New technology allows for more data to be collected, which results in new challenges with data management and data synthesizing. With the increased amount of data being collected, there is a lack of workforce to properly manage and interpret this beneficial data.

Agencies have also found that there are recruitment and retention issues with mid-level employees. This has either forced departments to have a substantial knowledge gap between junior- and senior-level employees or promote junior-level employees into mid-level roles too soon. This challenge creates further issues with knowledge management. Lacking an entire level of employee experience results in inadequate knowledge transfer between junior- and senior-level employees. Furthermore, promoting junior-level employees too soon forces these inexperienced employees to rely on senior-level employees, adding more responsibilities for senior-level employees.

During the interview process, many participants mentioned the challenges with the increased use of contractors and consultants. Because of this, agencies need employees to have not only technical skills but also project management and communications skills to efficiently and effectively work with contractors and consultants.

Generational differences in the workforce have brought on unique challenges for retention and knowledge management. As mentioned above, older generation workers find it hard to adapt to new technologies. They are also less inclined to get excited about adopting new technologies than younger staff and are less inclined to do so. Many departments mentioned a need for a comprehensive system to teach older generations new technology in a timely and efficient manner. This has also put a strain on retaining younger staff members. Departments are struggling to create a marketing strategy that attracts younger workers to the public sector versus the private sector. They have also found it difficult to change their training system to be more web-based as opposed to classroom-based to align with younger people's preferences. It is a struggle to keep millennial workers busy and engaged in their work. Ultimately, agencies need to account for the fact that younger people tend to move jobs more frequently and stay within a position for a short period of time.

Workforce Development Challenges

The need for workforce development has brought on distinctive challenges for the transportation industry. There is a push for better career development by all levels of employees. Some of these challenges include a need for better job descriptions and affording employees the time to train in

different areas of interest. With this, DOTs need to gain a better understanding of career pathing and detailing the training necessary for employees to develop their skill sets. A major issue recorded in multiple interview sessions was the lack of career development for certain occupations. In some cases, career development is only available for occupations like engineering and not for other occupations, like construction and maintenance. Participants discussed how career development should be offered to all positions to maintain a strong design, construction, and maintenance workforce.

IV. Preliminary Solutions and Best Practices

Recruitment and Branding Solutions and Practices

To address challenges with recruiting employees and industry perceptions, participants recommended affiliating with educational institutions, rebranding the industry, adjusting hiring standards, pulling from nontraditional job applicant pools, spreading job postings, and extending offers sooner. Participants also discussed how surveying employees' needs helped their DOTs offer feasible alternatives to flexible work hours and telework.

Collaborations with educational institutions include working with local elementary, middle, and high schools; trade schools; community colleges; and universities. Though many DOTs work with schools, each of their strategies varied. For example, the Washington State DOT hosts summer camps for children, while the Kentucky Transportation Cabinet talks to middle and high school students about job opportunities in the transportation industry. Additionally, several DOTs (e.g., Michigan, Utah, Minnesota, Washington) host internship programs for college students; others (e.g., California, Minnesota) develop curriculums for trade schools. DOTs that collaborate with schools believed their efforts improved community building, developed a talent pipeline from schools to their agency, and provided children and young adults with an accurate depiction of the transit industry. Along with outreach to children and young adults, several participants discussed how a unified marketing strategy could debunk stereotypes about blue-collar jobs and the industry. These participants thought if people knew they could have meaningful careers and contribute to the community, they would be more likely to apply to DOTs.

As for current hiring practices, some DOTs, like Minnesota, adjusted their hiring standards by removing certifications and trainable skill sets from their hiring requirements. DOTs using this strategy needed to fill jobs and accepted that they could train employees on the job and provide them with resources to obtain certifications post-hire. This has helped these DOTs not only develop their employees but also fill jobs. Similarly, several DOTs have turned to nontraditional job applicant pools to fill their jobs. Washington and California collaborate with prisons, where they train soon-to-be-released prisoners and provide jobs to them when they complete their sentence. Other states, like New Hampshire, work with the military and hire veterans. Additionally, participants discussed the importance of placing job postings in more places than just the DOT's website; participants recommended placing them online and doing targeted recruiting on LinkedIn. These participants also mentioned changing their hiring timeline to more closely mimic their competitors. In particular, the Michigan DOT now extends job offers to college students in September and not later in the school year, like April. They believe offering

jobs earlier helps their DOT stand out and prevents competitors from swaying students' job acceptance decisions.

Though DOTs reported challenges with the growing interest in flexible work schedules and telework, several participants discussed how alternatives could still interest job candidates and benefit current employees. For example, the Massachusetts DOT realized they could not offer telework for all its designers; however, after communicating with the designers they realized the designers just wanted to decrease their commute time. Massachusetts decided to establish a co-op at a university, which not only increased their collaborations with schools but also reduced the length of designers' commutes. Other DOTs offer occasional telework or provide alternative flexible policies, like allowing employees to bring babies under 6 months of age to work (e.g., Washington DOT). DOTs will need to independently decide which flexible work policies are appropriate for their office and for which job positions. Across all these examples, participants emphasized the importance of understanding employees' desires. Although full telework or flexible work schedules may not be possible, understanding employees' needs could help DOTs provide alternatives.

Retention and Knowledge Management Solutions and Practices

To improve employee retention and knowledge management practices, participants recommended reverse mentoring and slowly integrating technology, targeting recruitment of data scientists, establishing mentorship programs, formalizing knowledge management initiatives, ensuring project management and communication skills are incorporated in pertinent schools' curriculums, and understanding young hires' expectations.

Given rapid technological advancements have posed numerous challenges to DOTs, participants believed reverse mentoring—having junior-level employees who are more familiar with technology teach less familiar senior-level employees—effectively trained their employees and encouraged them to use new technologies. Additionally, a participant from Washington State DOT found slowly integrating technology helped their employees be more receptive to the changes and made it easier for employees to adjust to the new tools. These practices not only help integrate technology into DOTs but also help older employees learn and accept the changes new technology imposes. Coupled with technological advancements, few participants provided solutions for their data scientist shortages. However, one participant from the Washington, DC, DOT believed purposefully recruiting from local data science programs and better communicating how data science is used in DOTs helped attract more data scientists.

Many participants reported deficits in mid-level employees. Previously discussed recruitment solutions, such as targeted recruiting, could help some DOTs fill these positions. Other solutions that participants mentioned include mentorship programs where a senior-level employee mentors a junior-level employee. This would allow the senior employee to teach the junior employee the skills and knowledge the junior employee needs for a mid-level role. As for the knowledge management challenges that come with lacking mid-level employees, several participants discussed implementing formal knowledge management initiatives. These initiatives include better documentation of processes and quick, accessible reference guides for employees. Furthermore, Michigan's DOT has purposefully integrated knowledge management tools,

initiatives, and practices into their workplace culture, making knowledge management practices routine and the standard for their DOT. Prioritizing knowledge management and making it easy for employees to maintain has helped DOTs solve knowledge management pitfalls.

To address the challenges of working with contractors and consultants, several participants emphasized how, unlike before, employees need project management and communication skills. Given that recruitment is already a challenge for DOTs, participants discussed how their DOTs work with nearby schools and ensure project management and communication skills are taught in their trade programs. This not only improves collaboration between educational institutions and DOTs but also gives DOTs the power to mold the training process for their future workforce to match their current needs.

As for disparities between older and younger employees, participants discussed how understanding applicants' and new hires' job expectations helped them solve their discussed challenges. For example, the Washington State DOT conducted focus groups to determine new hires' expectations and found new hires expected the DOT to provide engaging work and compensate them if they worked overtime. Washington responded by creating more engaging opportunities for new hires and giving all employees personal time when they work overtime. Directly identifying new hires' expectations helps DOTs quickly identify differences, offer solutions, and ultimately improve retention.

Workforce Development Solutions and Practices

Participants discussed how investing in career development initiatives helped them respond to their workforce development challenges. Discussed career development programs often included initiatives like career coaching for recent hires (California DOT), paired mentors (California and Michigan DOTs), and creating career roadmaps for all employee levels, including maintenance and construction (Nebraska DOT). Several DOTs (e.g., Michigan, Indiana, New Jersey, Texas) also reported cross-training programs, where they had recently hired engineers undergo training across all the DOT's divisions and select which division they would prefer to work in. DOTs who did this believed it helped improve retention, as it educated new hires about the organization's structure, provided them with more skill sets, and allowed employees to have autonomy in their career paths

Appendix E. Survey of State DOTs for Priority Jobs, Challenges, Future State of the Priority Jobs, and Related Best Practices

ICF, in partnership with the National Cooperative Highway Research Program (NCHRP), is working to develop a comprehensive set of effective DOT human capital strategies applicable to the transportation design, construction, and maintenance workforce through the year 2030. The focus of this project is to help transportation professionals:

- Understand the evolving workforce needs for the industry.
- Identify high-priority jobs within the occupational areas of construction, maintenance, and design.
- Describe innovative workforce and human capital programs that DOTs can leverage.
- Recommend organizational process and policy improvements that will enable DOTs to maintain, hire, and grow their staff to meet future industry demands.

We recognize that the unique nature of transportation design, construction, and maintenance work poses specific challenges to staffing not faced in other occupations. To capture and better understand these challenges, we are asking you to share some of your insights about future needs for the design, construction, and maintenance workforce by completing this survey.

In this survey, we will provide a comprehensive list of jobs in design, construction, and maintenance and ask you to rank the jobs based on how critical they will become in the next 10–15 years for how DOTs must operate. Based on your ranking, there will be a series of follow-up questions that will help us further understand which jobs are likely going to need the full attention of DOTs, particularly in terms of building a strong workforce and talent pipeline for the future.

All data collected for the survey is confidential and will be aggregated, meaning that your responses are non-attributional and will not be connected back to you. Any and all personal identifying information will be removed from the final production of the results and will not be shared outside of our ICF research team.

Please complete and submit this survey by **December 6, 2019**. We estimate that it should take no more than 15–30 minutes to complete. If you have any questions about this project, please contact Dr. Candace Blair Cronin at Candace.Cronin@icf.com. If you have questions about the survey or have problems related to this survey, please contact Dr. Allison Alexander at Allison.Alexander@icf.com.

Thank you for your participation!

General Information

1. Please select the occupational area(s) with which you very are familiar in terms of job roles and DOT workforce needs. [Select all that apply.]
 - Construction [Go to **BLOCK: Identifying Mission Critical Occupations-Construction**]
 - Design [Go to **BLOCK: Identifying Mission Critical Occupations-Design**]
 - Maintenance [Go to **BLOCK: Identifying Mission Critical Occupations-Maintenance**]
2. Please select your DOT/Organization’s state: [State drop-down menu]
3. Are you employed by a state DOT? [Yes/No]
 - If no: What is the name of your organization?
 - If yes: How would you describe the type of DOT you work in. Some examples of DOT “types” could include the following examples, hybrid of these examples, or another structure that is unique to your DOT: [Select all that apply.]
 - i. **“Smart state” DOT.** The transportation system is the backbone for a connected system. Examples include emergency response, signal timing, air quality, and communications. All state and local agencies coordinate together.
 - ii. **“Project management” DOT.** Project designs or programs (including maintenance and operations) are managed by DOT staff, and actual design work, construction oversight, and maintenance activities are contracted out and completed through consulting services. Internal staff members have project management knowledge.
 - iii. **“Traditional” DOT.** The DOT functions primarily the same as in the past, providing a combination of in-house and consultant services for design, construction, administration and testing, and maintenance activities. Internal staff members have design and program knowledge.
 - iv. Other (Please describe) [Open-ended response]
4. [If Yes to DOT question] From a financial perspective, which of the following do you believe is the focus of your DOT?
 - Maintenance focused
 - System expansion focused
 - Technology focused
 - Other focus: _____
5. How long have you been employed in the transportation industry?
 - Less than 5 years
 - 5 to 10 years
 - 10 to 15 years
 - More than 15 years

6. What is your current job?
- Employee (No supervisory responsibility)
 - First-level supervisor
 - Mid-level management
 - Executive leader
 - Contractor
 - Other: _____
7. [If Yes to DOT question] Which of the following best describes the [construction, design, or maintenance] work within your DOT? (Select all that apply)
- Majority of work outsourced
 - Majority of work conducted in-house
 - Centralized
 - Decentralized
 - Integrated functions
 - Distinct functions

Mission Critical Roles for Priority Jobs

What is a “mission critical job role”?

Mission critical job roles are those that are essential to the DOT’s greater mission including daily operations of the DOT and goals the DOT sets out to achieve. While all job roles within DOTs are valued and contribute to mission success, there are some that will be more critical for DOT longevity, effective operations, and innovative business successes.

Three criteria are typically used to identify job roles that are mission critical:

- **Strategic alignment to the DOT’s future plans** – The job role aligns with the visioning and continuous improvement efforts the DOT has conceptualized and the initiatives that move the DOT in that direction. Strategy is frequently based on both internal and external demands: internal demands refer to the individual DOT’s vision to maintain or adopt specific practices for the purpose of bettering itself (e.g., maintaining strong relationships with academic institutions and trade schools), whereas external demands involve government or regulatory requirements (e.g., FHWA mandates) to do business differently or more efficiently and without incident.
- **Required to achieve key DOT goals** – The job role ensures the DOT can achieve its goals regarding building a diverse workforce, leveraging technological advances, and addressing changing transportation needs.
- **High impact of vacancy** – The job role requires specialized skill sets that are difficult to find in applicants, is expecting a large number of retirements from the job role, or will have an insufficient pipeline of future talent (i.e., hard to fill vacancies). Should vacancies occur within this job role, continuity of operations could be seriously threatened.

We know DOTs are facing a number of possible futures that will impact workforce capacity needs. Through our research to date, four significant trends the DOT industry is experiencing include:

- Rapid emergence of new technologies to improve efficiency and reduce costs, including things such as safety technology.
- High competition with the private sector for potential employees.
- Increased focus on the bottom-line, including cost pressures on DOTs and outsourcing more work to contractors.
- Demographic changes in the DOT workforce, including significant retirements and a younger workforce.

Please consider these trends as you make your ratings regarding the mission critical job roles within DOTs.

Identifying Mission Critical Job Roles

Note: There will be a separate page for each occupation (i.e., Construction, Design, and Maintenance) so mission critical job roles in each area can be identified and one area does not “overshadow” another. Participants will only be shown the screens for those occupations for which they indicated knowledge.

8. Keeping in mind the definition of “mission critical job roles” and the types of future trends affecting DOTs, please rank the three (3) job roles from the list below that you believe will be the *most* mission critical in the next 10-15 years. That is, which job roles best meet the mission critical criteria of:
- 1) Helping DOTs accomplish their major strategic plans,
 - 2) Ensuring successful DOT performance, and
 - 3) Experiencing job vacancies would have a high negative impact.

You must rank exactly 3 job roles before you can move onto the next page. None of the selected job roles can have the same rank number, so you must give each of the top 3 its own rank number (i.e., 1, 2, or 3). Note that all job roles except for your selected 3 will be left blank.

[Insert Appropriate Job Role List for Section]

9. From your recent experience, please provide the names of any additional job roles or titles that exist within transportation [design, maintenance, or construction] which have NOT been featured in this list. Please also note which job titles in the given list are most closely related to the new titles you provide.
[Open-ended response]

Rating Mission Critical Job Roles

The following pages will ask questions specific to the **top 3 job roles** that you identified as most mission critical in the next 10-15 years. You will be asked to respond to questions about each of your selected job roles.

Note: Each job role will have its own page, with job role titles piped into each question.

Current Challenges for Mission Critical Job Roles

1. Think about the **[occupation]** job role. Indicate the extent to which you agree with the following statements about the current state of this job role. Currently, there is a:
[5-point scale ranging from Strongly Agree to Strongly Disagree]
 - a. Lack of training and development to support technical skills for the **[occupation]** job role
 - b. Lack of training and development to support personal effectiveness (managerial, interpersonal) for the **[occupation]** job role
 - c. Lack of credentialed education programs to prepare workers for the **[occupation]** job role real-world requirements with a DOT setting.
 - d. Small applicant pool when/if needing to fill a vacancy for the **[occupation]** job role
 - e. Skill set required for this job role is highly specialized, making finding employees difficult

- f. High level of turnover within the **[occupation]** job role
 - g. High competition across industries for skill sets required in the **[occupation]** job role/Better compensation or job attractiveness elsewhere
 - h. Lack of solid career track in DOTs for the **[occupation]** job role
 - i. Lack of talent in existing DOT employees to fill future vacancies in the **[occupation]** job role
 - j. Strong emphasis on leadership development for employees within the **[occupation]** job role (*Reverse Coded*)
2. In 10–15 years, how impactful will **[occupation]** be for achieving each of the following state DOT goals?
[Scale is Extremely, Moderately, Somewhat, Slightly, Not at all]
- a. Provide equitable multi-modal access and connectivity for community prosperity
 - b. Provide a safe and reliable transportation system
 - c. Leverage technological advances to improve transportation convenience and safety
 - d. Support a vibrant economy and economic vitality
 - e. Preserve and enhance infrastructure
 - f. Deliver the right project on time and on budget
 - g. Promote stewardship and preserve transportation system investments, protect the environment, and utilize public resources in a responsible manner
 - h. Deliver quality service through excellent employee performance, public communication, and accountability

Future Challenges for Mission Critical Occupations

3. Please answer the following questions regarding the future of the **[occupation]** occupation.
[5-point scale ranging from Strongly Agree to Strongly Disagree]
- a. The **[occupation]** occupation will be at risk for vacancy within my DOT in this next 10–15 years due to turnover or retirement.
 - b. The **[occupation]** occupation will be difficult to fill in the next 10–15 years due to insufficient skill sets, knowledge, or interest within the labor market.
 - c. The education and training available to prepare workers for the **[occupation]** occupation are insufficient to meet future job needs.
 - d. Emerging technologies will require new skill sets for employees within the **[occupation]** occupation.
 - e. Changing demographics, such as having a younger and/or more diverse labor pool, is likely to impact the **[occupation]** workforce in DOTs.
 - f. Because of knowledge loss due to retirements, employees in the **[occupation]** occupation will need additional developmental opportunities (e.g., job rotations, stretch assignments, coaching, mentoring, training).
 - g. Because of changing job requirements or work activities, employees in the **[occupation]** occupation will need new or additional training.

- h. The complexity of tasks performed under the **[occupation]** occupation will increase significantly in the next 10–15 years.
- i. Consequences of error by an employee in the **[occupation]** occupation will pose significant costs or challenges for my DOT.

The State DOT Workforce: 2030

1. Please describe any specific workforce challenges or specific capability gaps (e.g., skills, knowledge) your DOT is currently experiencing or expects to experience in the next 10–15 years. [Free response]
2. Please share examples of any existing training or education programs that you believe would serve as a valuable case study on effective and/or innovative ways to develop the future DOT workforce pipeline. If you have a contact for that program, please provide that as well. You may share a link to any information available online, or if you have informational materials, they can be emailed to [contact]. [Free response]

Conclusion

We appreciate you taking the time to provide thoughtful responses to this survey. If you are willing to participate in follow-up interviews or focus groups, please provide your contact information below.

Name: _____
Job Title: _____
Email address: _____

If you have any comments, questions or concerns, please contact Dr. Candace Blair Cronin at Candace.Cronin@icf.com. Thank you again for your participation.

Appendix F. Workforce 2030 Summary Report

I. Introduction

Report Overview

This Workforce 2030 Summary Report provides seven “future-state” scenarios that departments of transportation (DOTs) will likely face within the next decade. These future scenarios were developed based on findings from Phase 1 of NCHRP Project 02-25, input gathered from industry experts, and feedback from DOT leaders from across the United States. The methodology used to identify these scenarios is described in detail within this report.

Background

DOTs play a critical role in ensuring the integrity of our nation’s transportation infrastructure. Individuals in the design, construction, and maintenance workforce are trusted to ensure that infrastructure in the United States is safe, efficient, and effective. However, many DOTs around the country are finding it difficult to maintain a strong and fully capable workforce in these three functional areas given the number of industry changes that are taking place and will continue to develop over the next decade. These challenges range from emerging technologies to the rise of multi-modal transportation and changing infrastructure demands—challenges that will impact the way DOTs need to conduct their business. As a result, the design, construction, and maintenance workforce of 2030 will look much different than it does today. The DOT workforce of 2030 will be leaner, more infiltrated with private-sector contractors, and more technologically savvy. DOTs will require a human capital strategy that is both innovative and rooted in lessons learned and historic best practices from DOTs around the country to transition into this end state.

The purpose of NCHRP Project 02-25, Workforce 2030—Attracting, Retaining, and Developing the Transportation Workforce: Design, Construction, and Maintenance” is to conduct research regarding the current and future industry challenges and demands that will impact workforce needs for state DOTs over the next decade and beyond. The research conducted will help guide the development and implementation of practical strategies to improve how DOTs recruit, select, train, and sustain a capable workforce over the next decade to mitigate the negative impact of potential staffing and workforce challenges. This project will culminate in an industry framework, which will help unite DOT leaders and stakeholders in building workforce capacity across the industry, especially for mission critical occupations that are at greater risk due to shortages in the talent pipeline.

This project is divided into two phases. One of the major objectives in Phase 1 was to identify transportation trends, emerging challenges, and current and future transportation workforce needs. In completing Phase 1 of this project, various themes emerged during the interviews and focus groups, which made it clear that DOTs across the United States are grappling with some of the same challenges despite their geographical differences. The 11 predominant themes identified are as follows:

- Adoption of new technologies
- Booming national economy
- Rise of multi-modal transportation
- Climate change
- Blue-collar stigma
- Slow hiring practices
- Popularity and expectation of flexible workplace policies
- Difficulty recruiting and retaining mid-level staff
- Steady downsizing of DOT staff and the increased reliance on contractors
- Generational differences
- Difficulty recruiting, retaining, and engaging young staff

Following the completion of Phase 1, Phase 2 began with the end goal of using the information identified in Phase 1 to develop strategies that will help DOTs manage the current and anticipated industry challenges. As a part of identifying the practices and strategies that will best serve DOTs and the functional areas of design, construction, and maintenance, ICF first worked with industry stakeholders to identify several plausible future industry scenarios based on the themes presented above.

Purpose of Futuring Workshops

The purpose of conducting futuring workshops with transportation industry leaders is to identify plausible future states that DOTs will face over the next 5–10 years. Those future states point to where gaps in the workforce could be detrimental to the areas of design, construction, and maintenance if not adequately addressed by the industry. Further, those future states help to identify where work demands are shifting and new skills will be required to conduct business efficiently and effectively. The process of developing these scenarios also encourages DOT leaders to imagine how the transportation industry will be impacted and what the workforce must respond to over the next decade as a result of various new and evolving technologies, infrastructure changes, labor market shifts, economic fluctuations, and societal trends. The final future-state scenarios generated in this phase of the project will help guide the identification of workforce capacity-building strategies that DOTs can benefit from at state and federal levels as they prepare their workforce. The following section provides the steps ICF followed to develop the future-state scenarios.

II. Methodology

Step 1 – Draft the Initial Scenarios

Step Summary

ICF first enlisted the help of our five industry expert advisors to help brainstorm and generate initial content that reflects the changes DOTs are facing at a national level and that will directly affect how DOTs will manage their operations by the year 2030. The industry experts were as follows:

- **Mara Campbell, MBA**, Global Technology Leader – Transportation Performance Management and Policy (Jacobs Consulting)
- **Susan Gallagher**, Education and Workforce Program Manager (Western Transportation Institute; Montana State University)
- **Tyler Reeb, Ph.D.**, Director of Research and Workforce Development, Center for International Trade and Transportation (California State University)
- **Tom O'Brien, Ph.D.**, Executive Director, Center for International Trade and Transportation (California State University)
- **Glenn McRae, Ph.D.**, Director, Northeast Transportation Workforce Center; Outreach Manager, University of Vermont Transportation Research Center (University of Vermont Transportation Research Center)

The industry experts were asked to complete a worksheet to help build scenarios that describe potential future DOT operating environments, with a specific focus on design, construction, and maintenance functions (see Appendix G for the sample worksheet). The industry experts were asked to complete their worksheets by March 11, 2020, so some of their drafts could be presented to the panel in the interim meeting in March. This process resulted in a total of eight concepts from which the future-state scenarios might be built.

Process

The process we used to engage our industry expert advisors started with asking them to select three intersecting industry trends found in Phase 1 data collections to begin the development of a relevant future-state scenario (e.g., demographic shifts in the labor market, adoption of new technologies, generational differences). Next, the advisors were instructed to consider which type of DOT would be most impacted by the intersection of the three trends selected. They were able to choose a “Smart state” DOT, a “Project management” DOT, or a “Traditional” DOT.

The advisors were then presented with a series of questions regarding the industry trends they chose to focus on in their scenarios. The following is a list of some of the questions our industry expert advisors were given:

- What impacts should a DOT anticipate as they approach a reality like this?
- How is this being handled/addressed already across DOTs? How is this likely to change in the next 10 years? What are some examples in DOTs you have seen who are already responding or preparing for these types of challenges? (Please note real DOT names if you can think of examples).
- How will this impact the current transportation workforce and future workforce specifically in the functional areas of design, maintenance, and construction?

Finally, the experts were asked to draft preliminary scenario content by weaving in the information they provided above. They were informed that each scenario should include a narrative description (one to two paragraphs in length) that sets out three intersecting trends and their impact on the current and future workforce. The experts were also instructed to include a description of the leading indicators that will provide early signs to the transportation industry that this scenario is unfolding.

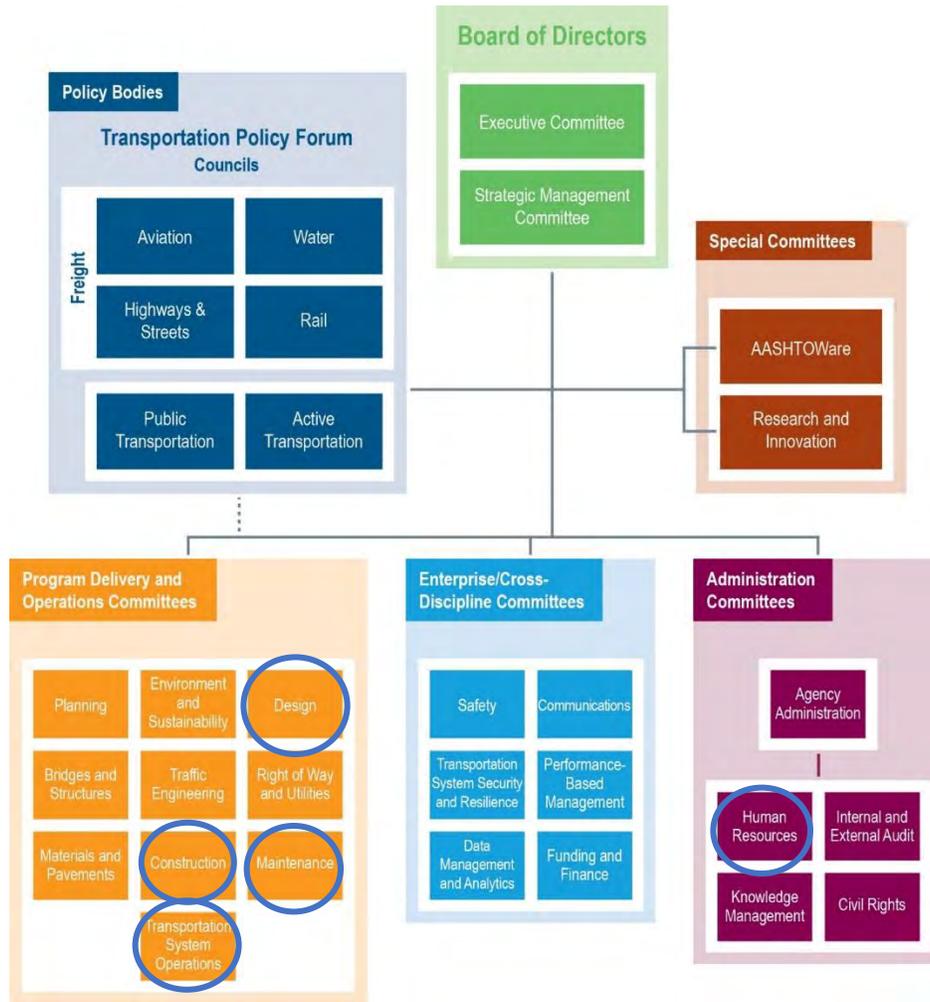
Step 2 – Engage Stakeholders to Review Future State Scenarios

Step Summary

After the scenarios were drafted by our industry expert advisors, ICF engaged with leadership and key stakeholders from various transportation agencies across the country in a series of four virtual *futureing* workshops. In these workshops, trained facilitators from ICF guided transportation leaders through a structured discussion that helped identify whether the scenarios accurately represent the future state of the industry and related transportation workforce challenges. In the workshops, ICF also led participants in a discussion of how design, construction, and maintenance would respond within the broader DOT context under each of the major changes discussed.

To recruit participants for these workshops, ICF worked with the industry advisors to identify contacts and leveraged existing state DOT contacts. For additional outreach, ICF also requested the project panelists submit any contacts they felt would provide valuable insight into the future needs of DOTs. Finally, ICF reached out to several AASHTO committees, particularly those representing design, construction, and maintenance, to obtain experts in these occupational fields. Participants were also recruited from the AASHTO human resources (HR) committee as these employees could likely offer a broad perspective on industry-wide challenges. The AASHTO committees circled in Exhibit F1 are the key committees that were targeted for these scenario review workshops.

Exhibit F1. Organizational Structure of AASHTO Committees



Originally, ICF proposed to organize one in-person, half-day to three-fourths-day workshop held in conjunction with another national meeting, such as the annual TRB conference, the AASHTO or HR subcommittee meeting, or the National Transportation Training Directors (NTTD) meeting. This was to ensure that all interested key stakeholders could join, given that these timeframes were already set aside in many of their calendars. However, due to COVID-19 and the risks associated with in-person meetings, ICF organized four virtual 1.5-hour workshops. These workshops were led by our principal investigator, Dr. Candace Blair Cronin as well as Dr. Allison Alexander and Dr. Jessica Jenkins, all of whom are highly experienced workshop facilitators.

Process

ICF began by identifying key questions that needed to be asked of stakeholders and produced a protocol to guide the futuring workshops (see Appendix B). ICF also prepared a schedule for when ICF expert facilitators and notetakers were available to conduct the focus groups.

ICF conducted the futuring workshops with 16 transportation professionals who were mostly seasoned DOT leaders. The occupations of these stakeholders ranged from transportation agency director to maintenance operations manager, research coordinator, and HR specialist. Please see Exhibit F2 for a list of all workshop participants.

| Exhibit F2. Scenario Review Workshop Participants | | |
|--|---|------------------------|
| Participant Name | Job Title | DOT Affiliation |
| John Paul Bilderback | State Construction and Materials Engineer | Idaho |
| Alicia Hunt | Assistant Division Head of Human Resources | Arkansas |
| Dan Stacks | Director of Maintenance | Texas |
| Barton A. Thrasher | VDOT Chief Engineer | Virginia |
| Jill Asher | Director of Highway Design | Kentucky |
| James Fults | Workforce Programs and Recruitment Unit Manager | Michigan |
| John D. Hancock | State Construction Engineer | Georgia |
| Adam Beasley | Talent Development Manager | Indiana |
| James Morin | Maintenance Operations Branch Manager | Washington |
| Kristin Schuster | Engineer of Design | Michigan |
| Jarrod Stanley | Research Coordinator | Kentucky |
| Zach Harman | Human Resources Specialist | Missouri |
| Josh Y. Harrouch | Traffic Engineering Development Administrator | Louisiana |
| George C. Lukes | State Design and Standards Engineer | Utah |
| Andy Paul | State Highway Design Engineer | Massachusetts |
| Denys Tak | Construction, Administration Engineer | Washington |

The workshops were held on April 29, April 30, May 7, and May 8 this year. In each workshop, there were three to five participants, one ICF facilitator, one ICF notetaker, and one industry expert advisor. Before each workshop, participants were emailed two of the eight scenarios for review. During the workshops, participants were presented again with the two scenarios and asked to share their thoughts on how realistic the scenarios were and whether there was enough detail included in the scenarios to fully capture the future state. Across the four futuring workshops, all eight future-state scenarios were discussed. Participants were specifically asked questions such as the following:

- How realistic is this scenario to what you expect most DOTs to face in the next 5–10 years? How about for your DOT?
- What additional elements/information should be included in this scenario to refine it further or provide greater clarity as to what has a high potential for occurring for DOTs?
- What challenge(s) would this scenario create for state DOTs in terms of building and growing their workforce?

The workshops were highly interactive with participants and included only a limited number of presentations from the ICF team outside of short overviews of the related materials and an introduction of the discussion questions. ICF documented the input from the workshop participants so that it could be referenced when refining the scenarios.

Step 3 – Revise Scenarios to Incorporate Stakeholder Feedback and Ensure Consistency

Step Summary

After conducting the four scenario workshops with the participants from various DOTs, the feedback given during these workshops was incorporated into the existing scenario content. For example, “climate change plan” was removed from one of the scenarios after some participants noted that “resiliency plan” is a better descriptor, and some states are prohibited from referencing the phrase “climate change.” Further, details pertaining to how each of the occupational groups will be specifically impacted by the various challenges were added based on the experiences of some workshop participants. The most significant change was the elimination of one of the scenarios due to heavy overlap with another scenario, resulting in a total of seven scenarios. After these revisions were made, ICF continued to improve the scenarios by ensuring they were written in a consistent format and included all necessary components.

Process

To ensure consistency between future-state scenarios, ICF made certain that each scenario included the following elements (see Appendix H):

- **Element 1:** The scenario must contain a brief explanation of two to three intersecting DOT challenges.
- **Element 2:** The scenario needs to include an explanation of the consequences of the DOT challenges (e.g., a significant shift in the DOT business model) and any risks involved (e.g., the DOT may be unable to recruit or retain employees).
- **Element 3:** The scenario should include an explanation for how each occupational group will be impacted by the challenges.
- **Element 4:** The scenario must contain a description of how this scenario might result in new workforce needs (e.g., skill gaps, difficulty recruiting certain talent, loss of current staff due to changes in services provided).
- **Element 5:** If possible, try to describe how external industry parties (e.g., consultants, FHWA, Regional Workforce Centers) may help DOTs in this scenario.

When a scenario did not include a necessary element, it was flagged so that ICF could ask our industry expert advisors for elaboration.

Step 4 – Meet with Industry Experts to Strengthen and Finalize Scenarios

Step Summary

To finalize the scenarios, ICF set up meetings with the industry experts on June 18, June 22, and June 23, 2020, so any remaining questions could be answered and any missing elements could be expanded. The information provided during this meeting was documented and incorporated into the scenarios.

Process

In preparation for this meeting, the revised scenarios were distributed to our industry expert advisors for review. In the meeting, our advisors were asked to answer a series of questions intended to encourage further thought about the details of the scenarios and their impacts (see Appendix I). Some of the questions were as follows:

- Who are the key players in the industry who would be influential in responding to or creating partnerships to address the impending workforce challenges related to this scenario?
- How would the construction workforce be specifically impacted for a DOT under this scenario?
- How would the design/engineering workforce be specifically impacted for a DOT under this scenario?
- How would the maintenance workforce be specifically impacted for a DOT under this scenario?

After this meeting, the feedback provided by the industry advisors was incorporated into the scenarios, and the scenarios were finalized. The following section provides the final format of each of the scenarios.

III. Futuring Scenarios

Overview

The final scenarios are presented in this section. These scenarios highlight the capability and talent needs required for DOTs to conduct business effectively given the likely industry changes in the next decade.

Across the seven scenarios, several major themes emerged. For example, as the demand for multi-modal transportation increases, there will need to be changes in how DOTs design, construct, and maintain infrastructure to accommodate these needs. Further, with expanding mobility service options (e.g., e-scooters, ridesharing services), the use of transportation infrastructure will also change, and new design, construction, and maintenance practices may be required to accommodate new uses. DOTs are also beginning to adopt new technologies to work smarter or more remotely (e.g., automated equipment, drones). However, some DOTs are having trouble recruiting, retaining, and engaging technologically savvy staff, which impacts their

ability to implement any new technologies. For this reason, DOTs are being forced to increasingly rely on contractors and consultants due to skill gaps among current staff. Many DOTs are also beginning to adopt new resiliency plans to help mitigate potential flooding or drainage-related issues, which results in an increased demand for specialized workers (e.g., individuals with backgrounds in drainage and flooding). However, DOTs have historically limited their workforce by mostly attracting and retaining more homogeneous types of employees without the demographic and educational diversity that would benefit the transportation organizations of the future. To attract and retain younger workers, women, people of color, and those from nontraditional, even non-transportation backgrounds, DOTs need to create more inclusive work environments. Many DOT employees are also asking for the implementation of more modern or flexible workplace policies (e.g., options for remote work, increased autonomy, flexible work schedules), and DOTs will need to consider this demand as they compete against other organizations for employees. Finally, for the first time, there are five generations in the workforce at once, so DOTs are anticipating some generational differences that will complicate working relationships.

More detailed descriptions of each future-state scenario are provided in the following text.

Scenario 1: Changing Transportation Infrastructure

The rise in popularity of alternative modes of transportation is requiring this State DOT to consider how roadways will be designed, built, and maintained to accommodate these new modes. With expanding mobility service options, the use of transportation infrastructure will also change, and as traditional automotive modes give way to tech-assisted modes, the transportation industry will be faced with decreased demand for typical design, construction, and maintenance operations. As new technologies and enhanced consideration for the environment impact how people customize and manage their multi-mobility choices, this State DOT has found itself marginalized by private companies in their roles as service provider, owner of system-user data, communicator with transportation system users, and influencer impacting user decisions. The risk is that profit-motivated system design and data collection and analysis will become dominant over analysis aimed at improving safety, efficiency, or other public transportation benefits. This may result in missed opportunities and inefficiencies for this State DOT. Policies and services aimed at equity and inclusion (e.g., accessibility, investment in under-resourced zones) will become more difficult to monitor and enforce. Indicators that this scenario has become a reality for the State DOT include:

- Privately managed mobility options begin rapid market penetration (e.g., e-scooters, ridesharing) and include mechanisms for user data collection, analysis, and sharing.
- Inefficiencies are realized through the continued use of legacy systems and the lack of data science expertise on staff.
- Data use standards and other regulatory safeguards are not in place.

The challenge for the State DOT facing this future will be developing project management expertise in this complex environment and establishing structures that allow the organization to manage mobility service providers effectively. This must be accomplished in a manner that benefits local communities through expanded mobility options while ensuring that the

transportation system is managed as a public good addressing a variety of user needs. As personally owned vehicles may be decoupled from the concept of individual mobility in the communities served, especially in urban areas, so too could value increasingly shift away from physical assets and toward the digital capabilities that enable safe, clean, efficient, and customized travel on demand. As a result, data, networks, software, and services are likely to grow increasingly important in all facets of transportation, which could come at the expense of traditional engineering (design, construction, and maintenance). Thus, engineers and designers within state DOTs will need to design for new demands (e.g., narrower highways, smaller shoulders on highways), and may not need to account for as much weight on highways. With these transitions, maintenance and construction workers will also be impacted. For example, new infrastructure will need to be repaired, replaced, and maintained by a workforce that will have to expand its skill set.

Scenario 2: New Smart Technologies

Smart City applications are expanding regionally, allowing this State DOT, a smart state, greater opportunities to connect urban and rural areas through technology deployments, coordinated services, and statewide system management practices. These applications involve looking at how to use sophisticated, data-driven resources (e.g., automated equipment, drones) to work a little bit smarter or more remotely. Within transportation design, new transportation technologies are emerging that will dramatically change how vehicles operate on roads and bridges, thereby changing design specifications and materials that should be considered for future infrastructure design. For example, some new technological advancements include road weather information systems, automated curb warning systems, and environmental sensor stations. In response, maintenance staff must increasingly focus on rural communications systems, power, and Intelligent Transportation System (ITS) maintenance issues. For example, bridges and roads need to be overlaid with electronics and sensors that will have to be installed, repaired, replaced, and maintained.

In construction, for example, new automated techniques such as 3D printing, drones, or robot swarms are being considered to accelerate construction projects. These technologies will require the construction staff to have skills and experience in areas that are more in line with electronics than traditional construction. One of the most exciting opportunities as the need for fresh skills is in demand, is the potential confluence between design, construction, and maintenance, in which technology allows more seamless transitions and communication between these areas. The State DOT recognizes the opportunity to create “living models” in this way but has not yet mapped out the changes in processes and technology that would be required to effectively implement it.

Those in management-level positions in all three of these career fields (construction, maintenance, and design) will need to have a working understanding of how transportation data can be used to improve services. Managers will have to use this understanding to work with private industry to share information. However, the State DOT is aware that skill gaps exist among current staff and that budget constraints, slow hiring practices, and antiquated management approaches are complicating their ability to attract new tech-savvy workers. In fact, technological deployments are increasingly avoided by this State DOT because currently available maintenance staff and personnel skills are inadequate to ensure new systems will

remain functional long term, and implementing new technologies requires many levels of approval within the State DOT. The DOT knows that these complications, if not proactively addressed, will slow the deployment of smart transportation technologies statewide, and the mobility, safety, and efficiency benefits will not be equitably accessible across the state. In fact, to execute project delivery in a timely manner, the State DOT may need to increasingly contract with construction firms that also have the technology skills required to effectively execute planning and utilizing 3-D modeling and other sophisticated software that is valuable to complete the job. Further, the State DOT may find that establishing working relationships with mobility service providers like Uber, Lyft, Bird, and others must be established so data can be shared for the public good, and the community can be better served.

Scenario 3: Attracting a Diversified Workforce and Increasing Labor Force Participation Rates

Within the next 10 years, the U.S. economy will also transition to a services-based, worker-supply-driven world, and even the transportation industry will be affected by this shift. However, this State DOT is finding itself ill-equipped to provide the innovative services being pushed. This DOT has historically narrowed its applicant pool and workforce unintentionally by mainly attracting and retaining workers who are White people, male, under 40 years of age, and living in urban areas. Further, any diversity that exists within the broader workforce thins as one ascends the leadership ranks. As a country, there is increased attention on promoting equity in the workplace, and for this DOT to be recognized as an “employer of choice,” it will be important for the DOT to show a renewed commitment to employment practices that support diversity and inclusion. With the growing need for new talent, this DOT must also recognize that expanding its applicant pool to even nontraditional hires is essential to business and will promote innovation by bringing unique perspectives together. Apart from having a narrow recruitment strategy, this State DOT is already battling a small talent pool simply because its headquarters is in the relatively small state capital and few skilled workers live there. Similarly, substantial growth in major metro areas, college towns, and resort areas is expected, and a lack of skilled and unskilled workers in these more rural areas may result in understaffing for many. Thus, this DOT cannot afford to ignore the call for more equitable workplace strategies and practices that will attract a broader audience to their job postings.

To broaden the applicant pool and demonstrate an ethical and moral commitment to diversity and inclusion, this DOT must look closely at how it recruits, develops, and retains minority workers. This DOT must also identify the current workplace policies and practices that may inadvertently create negative workplace realities for certain groups of workers. Further, this State DOT must begin to assess why the composition of its workforce does not mirror the demographic makeup of the communities it serves. If unable to recruit and retain from a nontraditional labor pool, the State DOT will be forced to overextend its current workforce to complete projects and may soon find itself with a significant deficit of talent as seasoned workers retire and minority workers leave for more supportive work environments.

Scenario 4: Competing for Specialized Skills

This State DOT is faced with the reality that employment within their organization will become more specialized due to new technological advances. For example, with new sensors on the road that generate big data, employees with the ability to analyze and utilize this data will be needed in this DOT. These new employees, who likely have backgrounds in data analysis or information technology (IT), will need to be woven into the decision-making process across DOT occupational areas (i.e., design, construction, maintenance) and the DOT's mission. Since attracting skilled workers will be challenging, particularly with fewer entrants into the trades disciplines, larger pools of workers will need to be created, which will allow the State DOT greater access to potential employees. However, competing against other sectors or industries may make it difficult to recruit and hire qualified staff. In addition to these recruitment challenges, the State DOT realizes that travel demands are shifting, and as they shift, the DOT will need to shift with them by having the agility to anticipate and react. The change in travel behaviors will result from increased demand for multi-modal transportation, therefore changing the landscape of how DOTs will need to design, construct, and maintain infrastructure.

Employees in design, construction, and maintenance will all be affected by these technological advancements and changing infrastructure demands, and each area will need to recruit and retain employees who have the necessary backgrounds to work within these changes. For example, someone with a greater knowledge of technological advancements may be required for design work to avoid spending a large portion of the DOT budget on systems that will need to be replaced within a few years. Engineers will likely also be affected by increased demand for the ability to communicate with interdisciplinary teams given the projected increase in collaboration with consultants and contractors. Employees who work in construction will need to adapt to using technology as new advances materialize (e.g., tablets on job sites). Similarly, maintenance workers will need to have the ability to keep new technological advancements functional and operate new maintenance equipment. Further, with increasing technological capability, the DOT has begun to amass an overwhelming quantity of data. The DOT has a difficult time finding qualified data analysts that understand the DOT setting, and currently, the agency feels it is only scratching the surface of what could be accomplished with its data.

Given increasingly complex infrastructure demands, a limited number of skilled workers, and difficulty competing against other sectors for new hires, the state DOT may need to start outsourcing more services. However, one problem with this approach is that when shifting work to consultants and contractors, employees may not retain the necessary knowledge to make proper inspection decisions or effectively review the contractors' work. Overreliance on consultants and contractors may also result in loss of ownership in project design, which can lead to employees feeling as though they are not able to substantially contribute to projects.

Scenario 5: Changing Nature of Work with a Multi-Generational Workforce

This State DOT is finding the integration of multiple generations of workers within its department is not as seamless as once anticipated. Younger generations entering the public sector workforce are proposing improvements to current processes that question the status quo. Seasoned workers are sometimes frustrated by the lack of institutional knowledge held by these

new entrants, and the established employees often feel they are being treated as if they are dispensable. For the first time in the modern age, five generations are present at work – traditionalists, baby boomers, Generation X, millennials (Generation Y), and Generation Z. Generational preferences may sometimes compete with one another. The DOT has found that its older workers tend to be frustrated with technology changes, while the younger generations are frustrated that the pace of technological change is too slow. The leading indicators providing early signs that this scenario is unfolding would be that technology gets more advanced, and the DOT cannot maintain the adoption rate, falls behind, and becomes almost obsolete. In addition, there will be a significant turnover in staff due to workplace policies as well as significant turnover in Gen XYZ due to a lack of change/collaboration from older generations.

Traditional management practices—such as requiring employees to work in person as opposed to remotely, adhering to an inflexible weekly work schedule, and limiting the amount of individual autonomy—are causing difficulty in recruiting new talent, especially when competitors are moving toward these new approaches. The State DOT recognizes work schedules must become more flexible moving forward than they have been traditionally as younger workers seek to have more work-life balance. More employees will expect to work from home and/or request more variable hours per week. With these changing schedules, the DOT has realized that physical workspace requirements will be reduced. Even in cases like frontline maintenance, where workspace and scheduling might not be as flexible, new technologies may affect the pace and approach to conducting work. As new technologies may automate and augment how work gets done, an equally fundamental shift could take place in why work gets done. New workers are pushing more and more to understand the meaning and value of their work. These applicants are asking about the impact of the work to be conducted, and transportation is increasingly finding it is important to showcase how the DOT workforce has a direct, positive effect on the lives of others.

Scenario 6: Resiliency Planning

Within a traditional State DOT, the implementation of a new resiliency plan has begun. Within this new plan, there will be changes to the way this DOT has traditionally planned for a rising sea level, flooding, and coastal storms, to ensure that infrastructure remains safe and reliable over time. However, one challenge associated with implementing this new resiliency plan is the limited number of staff with the required skills to engage in discussions over designing, constructing, and maintaining these new standards (e.g., forecasting, modeling), but these discussions have a very large impact on future operations. For example, when the state DOT needs to build a bridge over marshland, they will now need to design the bridge with consideration to how the marsh will rise over time. However, they only have a few employees who understand how to design a bridge in that way. Meanwhile, this traditional DOT must also address policy changes associated with the election of a new administration, along with budget cuts and downsizing.

All occupational areas within this DOT will likely be impacted by these policy changes. Engineers within the design occupation area will need to consider new policies when designing new infrastructure and planning for existing infrastructure. For example, they may need to consider strengthening or abandoning existing infrastructure and raising the standards for the

resilience of new infrastructure. The decisions made by engineers will trickle down to employees in construction and maintenance. Thus, implementing the resiliency plan requires that the DOT, with offices at both the headquarters and district level, coordinates the efforts of its construction, maintenance, and design units to implement the new plan. Implementing this plan will likely require design staff to clearly communicate and use tools such as databases to document their rationale for certain design decisions to ensure that all DOT occupational areas (i.e., construction, maintenance, and design) have a shared understanding of project decisions.

Along with these logistical considerations, macroeconomic factors can complicate policies. For example, a state mandate to assess fees to accelerate the transition toward alternative energy mobility will necessitate that the state DOT address new infrastructure options that have not been part of their core purpose up to now. This could include the intersection of transportation, telecommunications, and energy systems.

Scenario 7: Supply Chain Partnerships

This State DOT is applying for a U.S. DOT Build Grant totaling \$25 million to pilot a smart ITS corridor for freight traffic. Smart truck routing, a strong avenue to invest the grant into, uses real-time road data to optimize freight movement within a multi-modal context. The State, which serves as a major freight gateway for maritime, truck, rail, and cross-border freight traffic, will manage the network to ensure the most optimal routing. The State also has a large distribution, warehouse, and fulfillment network that supports markets across the country as well as local last-mile demand.

Design, construction, and maintenance teams have been asked to contribute; they must each identify costs to encompass untraditional wireless and wire line communications-based IT and electronic technologies into the DOT's road network, including costs of subsequent construction and maintenance. They must also provide an analysis of alternative system configurations and technology options to meet requirements. This includes institutional compatibility across agencies and life cycle costs of each alternative. In addition, they will need to assess a system's needs and its relationship to the regional architecture.

Developing the ITS freight corridor will require the DOT to build strong working partnerships with public- and private-sector supply chain partners as well as with leaders in the development and deployment of smart freight routing. The DOT will also need to introduce new data analytic and security methods and assess the efficiency of the systems while also ensuring their safety. For construction, the DOT will need to identify the necessity of building engineering system validation plans into construction processes and determine if ITS improvements can be incorporated into traditional federal aid construction contracts or if they are administered in a separate ITS contract. This requires more significant installation of underground infrastructure. Maintenance will need to identify the impact of advanced system architecture on scheduled maintenance and upgrades, including needed interface with systems maintained by other agencies and the central Transportation Management Center. Maintenance may also require more extensive and more frequent field and survey work. At design, construction, and maintenance, new positions may be required to effectuate system integration and integrated operations.

IV. Addressing Gaps for the 2030 Workforce

Each of the potential future states described in the previous section point to very specific needs for the transportation design, construction, and maintenance workforce of 2030. The implications of each scenario on workforce capacity-building are specifically described in this text.

Scenario 1 describes a future where a state DOT will face significant workforce capacity gaps unless it:

- prepares its workforce, business processes, and procurement practices for a more technology-driven world;
- adopts new policies and standards that ease the adoption of new technologies;
- allows for mistakes and learnings so workers become comfortable with experimenting with new technologies;
- upskills existing staff to broaden their functional expertise or hire new staff that possess project management expertise and are able to better manage projects with external stakeholders;
- identifies talent with data science or data modeling expertise who can operationalize multi-modal transportation data;
- determines how to effectively partner with and manage new mobility service providers; and
- identifies approaches and expertise needed for partnership with private industry and contractors to accomplish new infrastructure projects in their state.

Scenario 2 describes a future where a state DOT will face significant workforce capacity gaps unless it:

- identifies ways to address the cyclical challenge of needing personnel to maintain new technologies and presenting itself as an attractive place for tech-savvy individuals to work;
- determines how to address the deficits left by existing local education and training programs that do not specifically address the skills required by the state DOT and the difficulties of recruiting individuals from education and training programs in urban areas to work in rural areas;
- addresses civil service hiring requirements and job descriptions that do not align with the specialized skills required in the face of new infrastructure changes;
- balances reliance on outsourcing versus recruitment of new talent as overreliance on contractors can exacerbate skill gaps among current employees as workers begin to feel a loss of ownership in project design, and there are often challenges with ensuring accountability of consultants and contractors;
- agrees upon standards of performance with its industry partners to maintain the quality of work and not reflect poorly on the current DOT workforce and leadership; and
- cultivates project management and procurement skills among its designers, construction personnel, and maintenance workers to promote consistency and accountability in how the state's transportation projects are performed.

Scenario 3 describes a future where a state DOT will face significant workforce capacity gaps unless it:

- abandons its focus on recruitment strategies that unintentionally narrow the applicant pool and mainly attract and retain workers who are not demographically diverse;
- prioritizes the use of fair assessments in how it identifies high potential (HiPOs) employees and provides those HiPOs with developmental opportunities;
- creates meaningful job opportunities and employment benefits that matter to individuals with diverse backgrounds;
- cultivates an organizational culture that values differences;
- establishes recruitment and retention strategies that encourage minority employees to remain and seek out advancement within the DOT;
- conducts outreach to community organizations that support individuals of diverse backgrounds; and
- recognizes the linkage between diversity and innovation in the workplace as diverse teams and work units bring in unique backgrounds and perspectives.

Scenario 4 describes a future where a state DOT will face significant workforce capacity gaps unless it:

- prepares its design, maintenance, and construction workforce to adopt new data management and technology skills;
- partners with training, education institutions, and other transportation organizations to develop broader skill sets for employees;
- leverages talent from other functional areas within the DOT as well as other disciplines outside of transportation to build up the future talent pipeline;
- engages in community outreach and with local schools and vocational and trades programs to market the transportation industry and increase interest and awareness in DOT job opportunities; and
- identifies standards and performance expectations that can be agreed upon with contractors (when needed) to ensure consistency in quality, efficiency, and safety across projects and inspections.

Scenario 5 describes a future where a state DOT will face significant workforce capacity gaps unless it:

- identifies opportunities to create flexible arrangements (e.g., telework options) for workers that align with workers' professional and personal needs;
- promotes developmental activities that help workers identify their own generational biases;
- establishes programs that encourage knowledge sharing across employees with different levels of tenure at the DOT and with notable generational differences;
- identifies the value of unique perspectives each generation brings to the workforce; and
- recruits and develops younger talent to help fill in gaps for retiring workers.

Scenario 6 describes a future where a state DOT will face significant workforce capacity gaps unless it:

- teaches design staff how to use new decision tools, databases, and communication techniques to share their design decisions with other DOT disciplines (e.g., construction and maintenance) to create shared project understanding;
- develops planning skills and competency in the workforce so workers can become more engaged in preparing for the future and promoting resiliency; and
- builds a shared understanding of how the environment, climate, and weather all impact transportation and where traditional job roles in construction, design, and maintenance will be affected by those factors.

Scenario 7 describes a future where a state DOT will face significant workforce capacity gaps unless it:

- recognizes the increasing importance of building skills in risk tolerance and risk mitigation;
- builds a workforce that is guided in strategic thinking and being innovative (not just at the leadership ranks);
- cultivates a workforce that understands the intricacies of collaborative relationship building, coordination, and effective communication across disciplines, functional areas, and with agencies external to the DOT;
- educates the workforce on the importance of networking and partnering with public- and private-sector supply chain organizations to maintain a high pace of development and deployment of projects; and
- invests in new training on basic ITS systems to ensure workers are skilled in new data analytic and security methods and can execute those efficiently.

V. Next Steps

The next step in this project is to develop an industry framework based on the intersection of the scenario planning workshop results and Phase 1 findings. The industry framework should help unite key partners across transportation by specifying roles and strategies that major industry partners should take to ensure DOTs have an efficient and capable workforce over the next decade. This Industry Framework and the subsequent Guide developed in the next phase of this project will outline specific industry-wide partnership roles and responsibilities as well as best practices and action plans that individual DOTs may take to build workforce capacity in the areas of design, construction, and maintenance.

Appendix G. Worksheet Used by Expert Advisors to Draft Futuring Scenarios

NCHRP Project 02-25, “Workforce 2030—Attracting, Retaining, and Developing the Transportation Workforce: Design, Construction, and Maintenance”

Futuring Exercise Worksheet

Understanding

In preparation for the “futuring” workshops with DOT stakeholders, we would like to formulate differentiated and thought-provoking scenarios that will engage workshop participants in imagining challenges and changes DOTs are likely to face in the occupations of design, construction, and maintenance over the next decade or more. By outlining various scenarios likely to take place for different types of DOTs, we will have a foundation upon which to build workforce strategies to guide how related workforce efforts within DOTs should meet new operational demands. These futuring scenarios will also allow us to intentionally plan for how partners and stakeholders should respond to cultivate the talent pipeline for the occupational areas noted.

Methodology

The purpose of this worksheet is to gather your expertise in a structured way and begin to build out scenarios that describe potential future DOT operating environments, particularly with respect to design, construction, and maintenance functions. The scenarios you develop will serve as stimuli that we will use in the eventual workshops with DOTs. In those workshops, we will fully refine the scenarios and develop a final set of plausible, future states under which DOTs are highly likely to operate by the year 2030.

Specifically, we are requesting at least two scenarios from you. The instructions below provide guidance on the development of the two draft scenarios. Each scenario should be 1–2 paragraphs in length and consider specific constraints and new industry demands with which the DOT may have to contend over the next 10 years.

Details on the structure of the scenarios: The scenarios should include three (3) intersecting trends and describe the infrastructure and operational changes that will need to occur within most DOTs, the challenges it will present to most DOTs, and the overall impact to the DOT workforce. The table below (*Themes of Industry Challenges*) includes the industry trends found in Phase 1 of the NCHRP Project 02-25 study. For example, a scenario might include combining a number of facets that are likely to occur together such as budget constraints; turnover; skill shortages or outsourcing; new regulatory requirements; and demographic shifts in the external labor market.

In addition, we are looking for scenarios to cover the different types of DOTs, such as:

- **“Smart state” DOT.** The transportation system is the backbone for a connected system. Examples include emergency response, signal timing, air quality, and communications. All state and local agencies coordinate together.
- **“Project management” DOT.** Project designs or programs (including maintenance and operations) are managed by DOT staff and actual design work, construction oversight,

and maintenance activities are contracted out and completed through consulting services. Internal staff members have project management knowledge.

- **“Traditional” DOT.** The DOT functions primarily the same as it does today: providing a combination of in-house and consultant services for design, construction administration and testing, and maintenance activities. Internal staff members have design and program knowledge.

Thus, please build one scenario that represents what a combination of 2–3 challenges/trends will look like for one of these three DOT types and then build a second scenario that features a different combination of trends for a different DOT type. For example, if you create a likely future scenario that we are referring to as a “smart state” DOT, then please have your second scenario represent a “project management” or “traditional” DOT. We realize these three DOT types do not represent the full spectrum of DOTs, and they are gross generalizations. Thus, if you have another common “DOT type” in mind, feel free to present it and make sure to provide ICF with a description so we can explain it to stakeholders in future workshops.

The following table presents some of the themes we heard about in the Phase 1 data collection. Please use this table to identify some trends that are likely going to intersect/work in conjunction to impact DOTs in the future. Then, in your scenario be sure to explain how a hypothetical DOT (DOT XYZ) that is a [insert DOT type] would have to respond in light of these changes, how operations and infrastructure would have to change, and how these would impact workforce and skill needs.

| Themes of Industry Challenges | |
|------------------------------------|--|
| Trend/Challenge | Description |
| Adoption of new technologies | The adoption of new technologies is changing current job roles and necessary workforce knowledge, skills, and abilities (KSAs). This is especially true for the domains of data science and statistical analysis. |
| Booming national economy | The good health of the national economy is raising the level of competition between DOTs and other employers for the same pool of potential employees. |
| Rise of multi-modal transportation | Multi-modal transportation is growing in popularity, and DOTs around the country are having to change the way they approach design, construction, and maintenance work in response. |
| Climate change | DOTs and the transportation industry as a whole are required to face the realities of climate change and build environmental considerations into the work they do. |
| Blue-collar stigma | Blue-collar work, including construction and design work, is wrongly stigmatized. DOTs are challenged with confronting this sentiment as well as debunking other misconceptions that affect their recruitment efforts. |
| Slow hiring practices | DOTs are burdened by slow hiring practices, which ultimately affect the way they attract and hire new employees. This puts DOTs at a disadvantage when compared to private employers. |

| Themes of Industry Challenges | |
|--|--|
| Trend/Challenge | Description |
| Popularity and expectation of flexible workplace policies | Flexible workplace policies such as the ability of employees to work remotely or make their own schedule are becoming more common to the point where some people expect these things from their employers. DOTs have been slow to adopt such policies and are suffering as a result. |
| Difficulty recruiting and retaining mid-level staff | DOTs are struggling to recruit and retain their mid-level staff in the areas of design, construction, and maintenance. These organizations often have to promote low-level staff to fill these vacancies, creating a considerable and troubling knowledge gap. |
| Steady downsizing of DOT staff and the increased reliance on contractors | The increased reliance on contractor support means more managing and less “doing.” This trend has created the need to develop project management and communication KSAs in the workforce. |
| Generational differences | Older generations and younger generations can perceive transportation work differently. This is especially true for integrating new technologies into day-to-day operations. Generational differences can also manifest in preferences for training and workforce development. |
| Difficulty recruiting, retaining, and engaging young staff | Attracting young people to a career in transportation design, construction, or maintenance is a challenge for DOTs for various reasons. Equally as challenging is making sure these young employees stay engaged at work and don’t decide to pursue other job opportunities. |

Instructions

Step 1. Each scenario should include three (3) intersecting trends and describe the environment it will create, the challenges it will present to the DOT, and the overall impact to the DOT. The “Themes of Industry Challenges” table can be used as a reference; it includes the industry trends found in Phase 1 of the study. For example, a scenario might include budget constraints; turnover; skill shortages or outsourcing; new regulatory requirements; and demographic shifts in the labor market.

In addition, the scenarios need to cover the different types of DOTs, such as:

- “Smart state” DOT
- “Project management” DOT
- “Traditional” DOT

Scenario 1

- Trends (choose three):
- DOT type featured (pick one):

Scenario 2

- Trends (choose three):
- DOT type featured (pick one):

Step 2. To help guide the development of the scenarios, a list of questions has been provided for each scenario.

Scenario 1

- What challenge(s) does this scenario create? What impacts should a DOT anticipate as they approach a reality like this?
- What are the risks involved?
- How is this being handled/addressed already across DOTs? How is this likely to change in the next 10 years? What are some examples you have seen (actual DOTs) who are already responding or preparing for these types of challenges? (Please note real DOT names if you can think of examples).
- What are internal/external forces that will also impact how a DOT would respond in this scenario? (Hint: Think regulations; other agency forces; education availability; labor trends.)
- How will this impact the current workforce and future DOT workforce specifically in design, maintenance, and construction?
- What additional services may be needed in the next 10 years?
- How would the industry know if this scenario is occurring for a DOT? What indicators could provide notice to a DOT that this scenario is unfolding?

Scenario 2

- What challenge(s) does this scenario create? What impacts should a DOT anticipate as they approach a reality like this?
- What are the risks involved?
- How is this being handled/addressed already across DOTs? How is this likely to change in the next 10 years? What are some examples you have seen (actual DOTs) who are already responding or preparing for these types of challenges? (Please note real DOT names if you can think of examples).

- What are internal/external forces that will also impact how a DOT would respond in this scenario? (Hint: Think regulations; other agency forces; education availability; labor trends.)
- How will this impact the current workforce and future DOT workforce specifically in design, maintenance, and construction?
- What additional services may be needed in the next 10 years?
- How would the industry know if this scenario is occurring for a DOT? What indicators could provide notice to a DOT that this scenario is unfolding?

Step 3. Draft the scenarios. Each completed scenario should include:

- A narrative description (1–2 paragraphs in length) that sets out three intersecting trends and their impact on the current and future (within the next 10 years) workforce.
- A description of the leading indicators that will provide early signs that this scenario is unfolding.

Scenario 1

[Instructions: insert content here]

Scenario 2

[Instructions: insert content here]

Appendix H. Protocol for Futuring Workshops

NCHRP Project 02-25, “Workforce 2030—Attracting, Retaining, and Developing the Transportation Workforce: Design, Construction, and Maintenance”

Futuring Workshop Protocol

Welcome and thank you for participating in this focus group. My name is [facilitator name]. I work for ICF, an international consulting firm that has been contracted by the National Cooperative Highways Research Program (NCHRP) to conduct this project. We also have my colleague [recorder name] on the phone, who will be taking notes during our call so that we are able to best capture your thoughts and experiences. Finally, we have [expert panel member name] on the call with us who is supporting this project as an expert advisor and has excellent insights into the highways industry.

The purpose of this project, NCHRP Project 02-25, “Workforce 2030—Attracting, Retaining, and Developing the Transportation Workforce: Design, Construction, and Maintenance,” is to gather information to solidify the current industry trends and demands that will impact workforce needs for state DOTs into the future. This project is aimed at developing practical strategies and tools to improve how state DOTs recruit, select, train, and sustain a capable workforce over the next 10+ years in light of significant labor market shifts, competitive forces, and broad industry changes.

Confidentiality Statement

All data collected from the focus group today will be aggregated with data from other data collections. Each comment reported will be non-attributable in that personal identifying information will be removed from the individual comments before the comments are presented externally to our ICF research team. No personal identifying information will be linked to specific responses.

Introduction to Workshop

In preparation of these futuring workshops, NCHRP Project 02-25 expert advisors formulated scenarios that highlight potential challenges and changes that state DOTs are likely to face in the occupations of design, construction, and maintenance over the next decade or more. By outlining various scenarios likely to take place for different types of DOTs, we can begin to build workforce strategies to guide how related workforce efforts within DOTs should meet new operational demands. These futuring scenarios will also allow us to intentionally plan for how partners and stakeholders should respond to cultivate the talent pipeline for the occupational areas noted.

The purpose of this workshop is to consider how the occupations of design, construction, and maintenance might evolve in response to these scenarios and determine the implications of the future scenarios for workforce capacity-building over the next 10 years.

The scenarios include multiple intersecting trends identified through data collections for this project. The scenarios also describe the infrastructure and operational changes that will need to occur within most DOTs, the challenges it will present to most DOTs, and the presumed impact to the DOT workforce.

Instruction

For each scenario provided, we will first ask that you review the draft content that our team has pulled together to initiate our dialogue today. After you review this content, we then take a few minutes to further expand and refine the scenario based on your input to our questions. After we have reviewed and refined the scenario, we will go through a series of questions intended to encourage further thought about the impact these scenarios could have and plan for how partners and stakeholders should respond to the scenarios to cultivate the talent pipeline for the occupational areas noted.

Questions (repeat these questions for each scenario assigned)

Scenario Refining:

1. How realistic is this scenario to what you expect most DOTs to face in the next 5–10 years? How about for your DOT?
2. What additional elements/information should be included in this scenario to refine it further or provide greater clarity as to what has a high potential for occurring for DOTs? (Note to facilitator: You may need to ensure the participant understands the scenario is only supposed to encompass 1–3 critical changes likely to occur such as IT, budgetary, resource limitations and not cover the whole gamut of changes within one scenario. That is why we will identify several plausible future states across these workshops.)

Scenario Impacts:

3. What challenge(s) would this scenario create for state DOTs in terms of building and growing their workforce?
 - a. What impacts should a DOT anticipate as they approach a reality like this? (*Hint: Think skill gaps!*)
4. Now, let's capture what this scenario looks like for specific disciplines.
 - b. What would occur for **maintenance** and how maintenance functions and operates? How would maintenance infrastructure look different if a DOT were to face this scenario? How would the maintenance workforce be specifically impacted for a DOT under this scenario?
 - c. What would occur for **construction** and how would this change the functions and operations of construction? What decisions would construction have to make differently? How would the construction workforce be specifically impacted for a DOT under this scenario?

- d. What would occur for **design/engineering** and how would this change how DOTs treat that function? How would the design workforce be specifically impacted under this scenario?
5. Considering how the three occupational areas (design, maintenance, and construction) intersect in achieving the DOT mission, please describe how this scenario might impact the interrelationships between design, construction, and maintenance functions in terms of how their workforce must work together on particular projects (i.e., life cycle = design the highway; build the highway; maintenance the highway). How might staffing and work requirements look different as well as the collaboration between these functions?
6. What additional job functions or capabilities might be needed in the next 10 years to help DOTs address a scenario like that?
 - e. Describe how this scenario could lead some jobs or job functions to become unnecessary or obsolete.
 - i. On the flip side, how might this scenario create new opportunities in the occupational areas?
 - f. What challenges will the current workforce have as their work demands shift under a scenario like this? (Consider how current skill gaps might grow even larger.) How would the work likely change?
 - g. How might certain job vacancies take on even more (or perhaps less) impact on operations?
7. What are external forces in the industry (the government) and internal to the DOT that will also impact how a DOT would likely respond in this scenario? (*Hint: Think regulations; other agency forces; education availability; geographic/regional differences; labor trends.*)
8. Who are the key players in the industry who would be influential in responding to or creating partnerships with to address the impending workforce challenges related to this scenario? Who are the key industry stakeholders in this scenario and what are the responsibilities of each of those stakeholders to support the future highways workforce?
 - h. Consider:
 - i. **FHWA (Federal Highways Administration):** The Federal Highway Administration provides stewardship over the construction, maintenance, and preservation of the Nation's highways, bridges, and tunnels. FHWA also conducts research and provides technical assistance to state and local agencies to improve safety, mobility, and to encourage innovation.
 - ii. **AASHTO (American Association of State Highway and Transportation Officials):** AASHTO is a standards-setting body which publishes specifications, test protocols, and guidelines that are used in highway design and construction throughout the United States.
 - iii. **Others?**

9. How is a future scenario like this already being addressed by some state DOTs? Would you please share examples of programs or initiatives you are aware of within your DOT or another DOT that involves planning for this type of scenario?
 - i. What types of activities are being done to plan for, mitigate, or change the impact that could happen as a result of this scenario taking shape? Specific to design, maintenance, and construction disciplines?

Appendix I. Instructions for Refining Futuring Scenarios

NCHRP Project 02-25, “Workforce 2030—Attracting, Retaining, and Developing the Transportation Workforce: Design, Construction, and Maintenance”

Refining Futuring Scenarios

Instructions

To write the scenarios consistently and in a way that is realistic, write them as “State DOT XYZ is facing... The DOT realizes...The DOT is now struggling with... The DOT knows this will impact the workforce in A, B, C ways...The DOT is reaching out to FHWA for support to...”

Use the elements as general guidance of what should be in each scenario. Please put the element number in parentheses so when we discuss or review as a group, it will be obvious where each element is addressed. If you get stuck on an element, also note where info is missing so we can ask our subs for help.

Element 1. Trends/Challenges Featured (4–6 sentences)

- Make sure each scenario includes 2–3 intersecting trends.
- Make sure it is clear how each trend will impact the way the DOT operates and/or how the DOT is structured. Be sure it answers “why does this trend matter?”

For example, a scenario might include budget constraints; turnover; skill shortages or outsourcing; new regulatory requirements; and demographic shifts in the labor market.

This table provides examples of possible trends:

| Themes of Industry Challenges | |
|------------------------------------|---|
| Trend/Challenge | Description |
| Adoption of new technologies | The adoption of new technologies is changing current job roles and necessary workforce knowledge, skills, and abilities (KSAs). This is especially true for the domains of data science and statistical analysis. |
| Booming national economy | The good health of the national economy is raising the level of competition between DOTs and other employers for the same pool of potential employees. |
| Rise of multi-modal transportation | Multi-modal transportation is growing in popularity and DOTs around the country are having to change the way they approach design, construction, and maintenance work in response. |
| Climate change | DOTs and the transportation industry as a whole are required to face the realities of climate change and build environmental considerations into the work they do. |
| Blue-collar stigma | Blue-collar work, including construction and design work, is wrongly stigmatized. DOTs are challenged with confronting this |

| Themes of Industry Challenges | |
|--|--|
| Trend/Challenge | Description |
| | sentiment as well as debunking other misconceptions that affect their recruitment efforts. |
| Slow hiring practices | DOTs are burdened by slow hiring practices, which ultimately affect the way they attract and hire new employees. This puts DOTs at a disadvantage when compared to private employers. |
| Popularity and expectation of flexible workplace policies | Flexible workplace policies such as the ability of employees to work remotely or make their own schedule are becoming more common to the point where some people expect these things from their employers. DOTs have been slow to adopt such policies and are suffering as a result. |
| Difficulty recruiting and retaining mid-level staff | DOTs are struggling to recruit and retain their mid-level staff in the areas of design, construction, and maintenance. These organizations often have to promote low-level staff to fill these vacancies, creating a considerable and troubling knowledge gap. |
| Steady downsizing of DOT staff and the increased reliance on contractors | The increased reliance on contractor support means more managing and less “doing.” This trend has created the need to develop project management and communication KSAs in the workforce. |
| Generational differences | Older generations and younger generations can perceive transportation work differently. This is especially true for integrating new technologies into day-to-day operations. Generational differences can also manifest in preferences for training and workforce development. |
| Difficulty recruiting, retaining and engaging young staff | Attracting young people to a career in transportation design, construction, or maintenance is a challenge for DOTs for various reasons. Equally as challenging is making sure these young employees stay engaged at work and don’t decide to pursue other job opportunities. |

Element 2. Consequences of this Scenario for DOTs (2–3 sentences)

- Try to make sure your scenario answers: “What challenge(s) does this scenario create?” “What impacts should a DOT anticipate as they approach a reality like this?”
 - Examples might include:
 - Limited money to address retention and recruitment of the right skill set
 - Different set of skills needed
 - Cultural barriers of a “Traditional DOT” – can’t think differently
 - Transportation as a service becomes more of a reality – work shifts
 - Significant shift in DOT business model
- Try to address this question with a sentence or two: “What are the risks involved?”
 - Unable to adjust and become ineffective with tax dollars
 - Unable to recruit or retain, therefore unable to deliver projects/services

Element 3. Impact or Example Situation That Would Occur for Each Occupation Based on Scenario (3–6 sentences)

- Describe what this scenario would look like for maintenance.
- Describe what this scenario would look like for construction.
- Describe what this scenario would look like for design/engineering.

Element 4. Workforce Implications (2–3 sentences)

- Describe how this scenario might result in new workforce needs (e.g., skill gaps; difficulty recruiting certain talent; loss of current staff due to changes in services provided).

Element 5. Stakeholders in Industry That Should Step In or Who Might Be Impacted by Scenario (2–3 sentences) - Note: It might be tough to come up with content for this element.

- Describe how external industry parties (consultants, FHWA, Regional Workforce Centers) could help DOTs in this type of scenario.

NOTE: If you see the words “Leading Indicators,” those refer to the types of events that would indicate to a DOT that this future is becoming a reality; that change is fast approaching so weave this into the body of the scenario if possible.

Appendix J. Protocol for Refining Futuring Scenarios with Expert Advisers

NCHRP Project 02-25, “Workforce 2030—Attracting, Retaining, and Developing the Transportation Workforce: Design, Construction, and Maintenance”

Refining Futuring Scenarios Protocol

Welcome and thank you for participating in this focus group. The purpose of this project, NCHRP Project 02-25, “Workforce 2030—Attracting, Retaining, and Developing the Transportation Workforce: Design, Construction, and Maintenance,” is to gather information to solidify the current industry trends and demands that will impact workforce needs for state DOTs into the future. This project is aimed at developing practical strategies and tools to improve how state DOTs recruit, select, train, and sustain a capable workforce over the next 10+ years in light of significant labor market shifts, competitive forces, and broad industry changes.

Introduction to Workshop

We have conducted futuring workshops with representatives from various organizations based on the scenarios you all formulated that highlight potential challenges and changes that state DOTs are likely to face in the occupations of design, construction, and maintenance over the next decade or more. We have since refined the scenarios based on those discussions but would like your input once again to strengthen and then finalize the scenarios.

Instruction

For each scenario provided, we will first ask that you review the scenarios as they have been modified from the earlier versions you provided. After an initial review of the scenarios, we will go through a series of questions intended to encourage further thought about the details of the scenario and their impact, and plan for how partners and stakeholders should respond to the scenarios to cultivate the talent pipeline for the occupational areas noted.

Each scenario is organized according to the following structure:

Element 1: Explains the trends and challenges the DOT will face and how they will impact the way the DOT operates and/or how the DOT is structured and answers “why does this trend matter?”

Element 2: Outlines the consequences of this scenario for DOTs.

Element 3: Includes the impact or example situation that would occur for each occupation (maintenance, construction, design/engineering) based on the scenario.

Element 4: Describes the workforce implications of the scenario and how the scenario might result in new workforce needs (e.g., skill gaps; difficulty recruiting certain talent; loss of current staff due to changes in services provided).

Element 5: This element is not currently included in all scenarios. It describes stakeholders/external industry parties in the industry that could help DOTs in this type of scenario.

Questions (repeat the following questions for each scenario assigned to this group)

1. What additional elements/information should be included in this scenario to refine it further or provide greater clarity as to what has a high potential for occurring for DOTs? (Note to facilitator: You may need to remind the participant that the scenario is only supposed to encompass 1–3 critical changes likely to occur such as IT, budgetary, resource limitations, and not cover the whole gamut of changes within one scenario. That is why we will identify several plausible future states across these workshops.)
2. What challenge(s) would this scenario create for state DOTs in terms of building and growing their workforce?
3. How would the **maintenance** workforce be specifically impacted for a DOT under this scenario?
 - What would occur for maintenance and how maintenance functions and operates?
 - How would maintenance infrastructure look different if a DOT were to face this scenario?
4. How would the **construction** workforce be specifically impacted for a DOT under this scenario?
 - What would occur for construction and how would this change the functions and operations of construction?
5. What would occur for the **design/engineering** workforce and how would this change how DOTs treat that function?
 - How would the design workforce be specifically impacted under this scenario?
6. Considering how the three occupational areas (design, maintenance, and construction) intersect in achieving the DOT mission, please describe how this scenario might impact the interrelationships between design, construction, and maintenance functions in terms of how their workforce must work together on particular projects (i.e., life cycle = design the highway; build the highway; maintain the highway).
 - How might staffing and work requirements look different as well as the collaboration between these functions?
7. What additional job functions or capabilities might be needed in the next 10 years to help DOTs address a scenario like that? How could this scenario lead to obsolescence?
8. Who are the key players in the industry who would be influential in responding to or creating partnerships with to address the impending workforce challenges related to this

scenario? Who are the key industry stakeholders in this scenario, and what are the responsibilities of each of those stakeholders to support the future highways workforce?

9. How is a future scenario like this already being addressed by some state DOTs? Would you please share examples of programs or initiatives you are aware of within your DOT or another DOT that involves planning for this type of scenario?
 - What types of activities are being done to plan for, mitigate, or change the impact that could happen as a result of this scenario taking shape? Specific to design, maintenance, and construction disciplines?

Scenarios

[Scenarios were presented here]

Appendix K. Interview Protocol for Industry Partners

Introduction

Welcome and thank you for participating in this interview. My name is [facilitator name], and I represent ICF, the consulting firm selected by Transportation Research Board's National Cooperative Highway Research Program. The intent of this project is to help DOTs identify challenges and then effective strategies for building a sustainable highway design, construction, and maintenance workforce. We also have [recorder name] on the line who will be taking notes on our conversation so we can review our discussion as needed when we aggregate the data.

The purpose of today's conversation is to explore how organizations like yours engage with state DOTs for the purpose of building a strong talent pipeline for the design, construction, and maintenance career fields. We're also interested in discussing how these partnerships can foster workforce capacity in these career fields. Lastly, we would like to get your insight on how these partnerships can be improved so that interactions are more productive for all parties and that outcomes are more impactful.

Confidentiality Statement

All data collected from the interview today will be aggregated with data from other sessions. Each comment reported will be non-attributional in that personal identifying information will be removed from the individual comments before the comments are presented outside our ICF research team. All personal identifying information we collect today will be used for record-keeping purposes only. While we will not link names to specific comments, we would like to represent your name and organization in a participant table as a show of appreciation for your participation. If it is the case that you share a best practice example of something your organization is doing around workforce initiatives, we may request during today's interview to name your organization related to that positive example. It is our goal to only represent your organization favorably and to ensure any constructive or challenging experiences are not tied back to the agency without your explicit permission. Are you comfortable with these terms?

Any questions before we get started? If not, then let's proceed.

Questions

1. Please introduce yourself and provide a brief overview of your background and current role.
 - a. What is the name of the organization you work for?
 - b. How long have you worked for this organization?
 - c. What is your job title? How long have you been in that role?
2. What do you see as your organization's role in supporting the transportation industry's design, construction, and maintenance workforce?

3. Could you please describe how your organization's programs or actions intersect with the work DOTs are doing in the design, construction, and maintenance career fields? How do you think your organization could better support DOTs to build up their future talent pipeline for these three disciplines? For example, consider training, development, knowledge management, or other initiatives that you believe could help improve the capacity of the highway workforce.
 - a. What kind of data or information does your organization use to inform these actions?
4. The intent of the industry framework we are developing is to engage as many valuable partner organizations as possible and encourage a united, industry-wide effort to build the future design, construction, and maintenance workforce. What do you envision your organization's role to be in promoting viable and productive cooperation with transportation stakeholders?
5. How does your organization engage directly with the workforce in design, construction, and maintenance fields? Within or external to transportation? (For example, how does your organization help recruit/develop/train/support workers in those career fields?) Please describe the nature of this engagement, including the purpose.
 - a. What opportunities exist for improving engagement with future construction, design, and maintenance workers? (*probe examples: sponsoring career days, outreach to students*)
6. Could you please provide any specific examples of effective collaborations/partnerships between your organization and state DOTs? What about partnerships between your organization and other organizations that have a stake in building a robust talent pipeline for these three disciplines?
 - a. If no examples from your organization come to mind, could you provide any examples of successful partnerships between other stakeholder organizations that you have observed? What made those partnerships successful?
 - b. Why do you think these collaborations/partnerships were so effective?
 - c. What opportunities exist for improving these partnerships?
 - d. What factors inhibit productive partnerships with state DOTs?
7. If state DOTs are interested in engaging your organization for support, how might they go about that? What mechanisms exist for initiating a mutually beneficial partnership? Where does the connection need to occur? With which department or lead?
8. Do you have any suggestions for other transportation professionals we should interview for this portion of the project? If so, please provide their email address if you can.

Appendix L. Industry Framework for Building a 2030 Transportation Workforce Pipeline

Industry Framework for Building a 2030 Transportation Workforce Pipeline



I. Introduction

The goal of this industry framework is to articulate a shared vision and goals for developing workforce capacity within state DOTs and across related transportation organizations. This framework is designed to encourage DOTs and transportation organizations to consider the multiplicative impact on industry-wide workforce capacity-building that is achievable when multiple stakeholders take ownership and engage in productive partnerships at state and national levels. This framework provides a consistent and integrated vision for transportation stakeholders working toward cultivating a strong, sustainable, talent pipeline for transportation design, construction, and maintenance occupations by the year 2030.

The purpose of this report is to describe the needs of state DOTs of varying types and their opportunities to engage the larger landscape of stakeholders who have a role in influencing the future expansion and development of the transportation design, construction, and maintenance workforce. The first section of this report provides contextual, background information regarding jobs in construction, design, and maintenance; the purpose and objective of this industry-level visionary framework; and the shared vision for the 2030 transportation industry that unites all key stakeholders. To understand the need for a shared, industry-wide vision of workforce capacity-building, this framework touches briefly upon the workforce challenges that will be faced in the target occupation groups of transportation design, construction, and maintenance by 2030, including the scenarios that may impact DOTs of varying sizes and innovation profiles.

Background and Expectations Regarding Future State DOT Workforce Needs

From 2019 to 2029, occupations within state DOT design, construction, and maintenance are expected to grow in a number of jobs.⁴ With this growth and potentially new ways of doing work, it will be important to develop relationships across the industry to support the state DOT workforce pipeline and workforce development.

⁴ U.S. Bureau of Labor Statistics Employment Projections, <https://www.bls.gov/emp/>.

Anticipated Job Growth from 2019 to 2029



Through a survey of state DOT representatives and stakeholders, priority jobs within transportation design, construction, and maintenance were identified. Labor market analysis and job projections provide information to help understand the potential demand for these priority jobs in the next 10 years. The labor market analysis focuses on the top five priority jobs in each of the occupational areas. For this analysis, data from the U.S. Department of Labor’s Bureau of Labor Statistics (BLS) Employment Projections were used to understand the potential demand for the identified priority jobs.

The first step of the **Labor Market Analysis** was to align each of the state DOT design, construction, and maintenance priority jobs with BLS Standard Occupational Classification (SOC) systems. The SOC codes serve as a statistical standard used by federal agencies to classify workers into occupational categories to analyze employment and industry trends. Each of the priority jobs and their associated SOC code and label is provided in Exhibit L1. One finding of note is that many of the priority jobs align with the same SOC occupations. For example, civil engineers, transportation engineers, and traffic engineers all fall within the same SOC occupational code (i.e., 17-2051, Civil Engineers). However, it is still important to consider all the separate priority jobs as their skill needs and job requirements can differ within those jobs.

| Exhibit L1: Priority Jobs and Associated SOC Code and Titles | |
|---|---|
| Design Priority Job Roles | Related SOC Code and Title |
| Bridge and Structural Designer | 17-3011: Architectural and Civil Drafters |
| Civil Engineer | 17-2051: Civil Engineers |
| Transportation Engineer | 17-2051: Civil Engineers |
| Transportation Planner | 19-3099.01: Transportation Planners |
| Traffic Engineer | 17-2051: Civil Engineers |
| Construction Priority Job Roles | Related SOC Code and Title |
| Civil Engineer | 17-2051: Civil Engineers |
| Construction Manager | 11-9021: Construction Managers |
| Transportation Construction Inspector | 47-4011: Construction and Building Inspectors |

| Exhibit L1: Priority Jobs and Associated SOC Code and Titles | |
|---|--|
| Transportation Technician | 17-3022: Civil Engineering Technologists and Technicians |
| Traffic Management Operator | 53-6041: Traffic Technician |
| Maintenance Priority Job Roles | Related SOC Code and Title |
| Highway Foreman | 47-4051: Highway Maintenance Workers |
| Highway Maintenance Technician | 47-4051: Highway Maintenance Workers |
| Civil Engineer | 17-2051: Civil Engineers |
| Snowplow Operator | 47-4051: Highway Maintenance Workers |
| Transportation Maintenance Specialist | 47-4051: Highway Maintenance Workers |

After the SOC codes for the priority jobs were identified, BLS projections data were reviewed. As previously described, some of the priority jobs map to the same SOC code; as such, there is not a separate data analysis point for each of the priority jobs. Rather, eight total SOC codes describe all the identified priority jobs. The BLS data present the number of jobs in 2019, the projected number of jobs in 2029, the change and associated percent change, the average number of annual job openings, and the average (mean) annual salary for the priority jobs. These data are presented in Exhibit L2.

| Exhibit L2: BLS Labor Market Analysis for State DOT Design, Construction, and Maintenance Priority Jobs | | | | | | | |
|--|---|-----------------------------|---------------------------------------|---|-----------------------------------|---|--|
| SOC Code | Occupation Title | # of Employees, 2019 | Projected # of Employees, 2029 | Change in # of Employees (2019–2029) | Percent Change (2019–2029) | Average # of Annual Job Openings | National Average (Mean) Annual Wage |
| 11-9021 | Construction Managers | 476,700 | 517,100 | 40,400 | 8.5% | 34,700 | \$95,260 |
| 17-2051 | Civil Engineers | 329,200 | 334,700 | 5,500 | 1.7% | 22,900 | \$87,060 |
| 17-3011 | Architectural and Civil Drafters | 102,900 | 100,300 | –2,600 | –2.5% | 8,500 | \$56,340 |
| 17-3022 | Civil Engineering Technologists and Technicians | 70,900 | 72,700 | 1,800 | 2.5% | 6,100 | \$53,410 |
| 19-3099 | Social scientists and related workers, all other <i>(Includes Transportation Planners)</i> | 38,800 | 39,100 | 300 | 0.8% | 3,600 | \$83,330 |

| Exhibit L2: BLS Labor Market Analysis for State DOT Design, Construction, and Maintenance Priority Jobs | | | | | | | |
|--|--------------------------------------|-----------------------------|---------------------------------------|---|-----------------------------------|---|--|
| SOC Code | Occupation Title | # of Employees, 2019 | Projected # of Employees, 2029 | Change in # of Employees (2019–2029) | Percent Change (2019–2029) | Average # of Annual Job Openings | National Average (Mean) Annual Wage |
| 47-4011 | Construction and Building Inspectors | 120,800 | 124,600 | 3,900 | 3.2% | 13,500 | \$60,710 |
| 47-4051 | Highway Maintenance Workers | 156,100 | 163,800 | 7,800 | 5.0% | 16,500 | \$40,730 |
| 53-6041 | Traffic Technician | 7,700 | 8,200 | 500 | 6.0% | 800 | \$47,480 |

Understanding these job projections helps provide insight into the types of skills that may be necessary in the future across state DOTs as well as the types of stakeholders to engage or partnerships to cultivate to promote cross-industry support for building the transportation talent pipeline.

Purpose and Objective of Industry Framework

Through ICF’s data collection efforts, we have seen that DOTs are often in “fight or flight” mode and feel as though they are searching for solutions to complex and perpetual challenges in isolation, especially when it comes to identifying the optimal human capital solutions and building the future workforce pipeline. However, external stakeholders and partners across the industry (e.g., universities, transportation-related associations) are facing similar obstacles and resource constraints to DOTs. Thus, attacking workforce issues alone often proves unattainable for some stakeholders and subsequently, efforts may be unnecessarily duplicated or mistakes repeated. By promoting an industry-wide approach to building the future transportation design, construction, and maintenance talent pipeline, these stakeholder groups can achieve efficiency and generate more robust strategic plans and initiatives to prepare for future workforce capacity needs. For this reason, it is beneficial for transportation entities, even beyond those named herein, to work together toward common goals and help one another overcome shared workforce challenges.

The framework provided in this report starts to articulate a shared vision and potential goals DOTs and transportation stakeholders could adopt to grow workforce capacity on a grander industry scale, considering the broader environment and network within which state DOTs operate. This framework presents a holistic model to coordinate participation across external organizations at state and national levels. More specifically, this framework will provide an integrated vision for the many stakeholders working toward building the design, construction, and maintenance workforce of 2030. Example partners include DOTs, AASHTO, FHWA, the U.S. Department of Education, the U.S. Department of Labor, local academic institutions, and training associations. Having a unified strategy and framework will be critical for ensuring the education community, federal stakeholders, state entities, and nationwide transportation

associations are aligned with DOTs in developing a robust workforce across the United S while also reducing fragmentation or redundancy.

Vision for the 2030 Workforce

In 2030, U.S. Departments of Transportation (DOTs) will need to have a workforce that can quickly and readily adapt to any technological advancements and policy changes, a robust talent pipeline that can fill in knowledge or skill gaps among the current workforce, modern and flexible management policies to keep employees engaged, while also providing equal employment opportunities. However, to make this vision a reality and establish a powerful system of talent flow, DOTs need key industry stakeholders to fully accept and step into their intended roles and help foster mutually beneficial partnerships with DOTs and other stakeholders.

II. Industry-Wide Obstacles

This section of the report describes the predominant industry challenges that have been uncovered as a part of data collection efforts and highlights how these challenges compare to the shared vision for the transportation design, maintenance, and construction workforce of 2030. This comparison should shed light on the significant industry gaps, which will point to places where goals must be articulated to guide the transportation industry toward the shared 2030 vision.

Methodology

ICF conducted stakeholder interviews and focus groups with 85 different transportation professionals representing DOTs from across the United States who do work or have worked in the transportation industry in some capacity; participants had an average tenure in transportation of 20 years. Occupations of these stakeholders ranged from transportation agency directors to construction directors, hydraulic engineers, bridge engineers, human resource directors, and branch managers. The ICF research team utilized a SWOT methodology to gather insights from participants on industry-wide strengths, weaknesses, opportunities, and threats that will impact workforce capacity-building across transportation design, construction, and maintenance jobs over the next 10 years. ICF conducted a thematic analysis of all the narrative results to identify the most critical obstacles the industry faces in terms of building this capacity at a national level.

Obstacles

Exhibit L3 displays the themes that emerged during the interviews and focus groups, making it clear that DOTs across the United States deal with many of the same workforce challenges despite their geographical dispersion. Overall, DOTs face difficulty adapting to changes (e.g., adoption of new technologies, updated policies, the rise of multi-modal transportation), meeting the needs of all employees due to individual differences in work style preferences (e.g., expectations for modern versus traditional management approaches), addressing skill gaps among current staff due to inability to recruit and retain entry- and mid-level staff, and slow

hiring practices. More detail on each workforce-related challenge is further described in Exhibit L3.

| Exhibit L3. Identified Industry Challenges | |
|---|---|
| Trend/Challenge | Description |
| Adoption of new technologies | The adoption of new technologies is changing current job roles and necessary workforce knowledge, skills, and abilities (KSAs). This is especially true for the domains of data science and statistical analysis. |
| Booming national economy | The good health of the national economy is raising the level of competition between DOTs and other employers for the same pool of potential employees. |
| Rise of multi-modal transportation | Multi-modal transportation is growing in popularity, and DOTs around the country are having to change the way they approach design, construction, and maintenance work in response. |
| Climate change | DOTs and the transportation industry as a whole are required to face the realities of climate change and build environmental considerations into the work they do. |
| Blue-collar stigma | Blue-collar work, including construction and design work, is wrongly stigmatized. DOTs are challenged with confronting this sentiment as well as debunking other misconceptions that affect their recruitment efforts. |
| Slow hiring practices | DOTs are burdened by slow hiring practices, which ultimately affect the way they attract and hire new employees. This puts DOTs at a disadvantage when compared to private employers. |
| Popularity and expectation of flexible workplace policies | Flexible workplace policies such as the ability of employees to work remotely or make their own schedule are becoming more common to the point where some people expect these things from their employers. DOTs have been slow to adopt such policies and are suffering as a result. |
| Difficulty recruiting and retaining mid-level staff | DOTs are struggling to recruit and retain their mid-level staff in the areas of design, construction, and maintenance. These organizations often have to promote low-level staff to fill these vacancies, creating a considerable and troubling knowledge gap. |
| Steady downsizing of DOT staff and the increased reliance on contractors | The increased reliance on contractor support means more managing and less “doing.” This trend has created the need to develop project management and communication KSAs in the workforce. |
| Generational or tenure-related differences | Leaders perceive older generations and younger generations view transportation work differently and have different expectations about how to engage with one another. More seasoned workers may have interest in continuing work the way it has always been conducted. These differences in work style preferences seem especially noticeable when integrating new technologies into day-to-day operations. Workers also differ in how they prefer to receive training and/or participate in workforce development opportunities. |

| Exhibit L3. Identified Industry Challenges | |
|---|---|
| Trend/Challenge | Description |
| Difficulty recruiting, retaining, and engaging young staff | Attracting young people to a career in transportation design, construction, or maintenance is a challenge for DOTs for various reasons. Equally as challenging is making sure these young employees stay engaged at work and do not decide to pursue other job opportunities. |

Due to these obstacles, it can be difficult for DOTs to achieve a unified 2030 vision for the transportation workforce. For example, because historically many DOTs have struggled with adapting to change (e.g., new technologies and processes), it will likely be difficult for these DOTs to attract or develop a workforce that can quickly and easily adapt to technological advancements and policy updates. Similarly, DOTs may struggle to create and maintain a robust talent pipeline due to their inability to recruit and retain entry- and mid-level staff, the blue-collar stigma of certain jobs, and slow civil service hiring practices. Finally, DOTs will likely face difficulty creating modern and flexible management policies that satisfy all employees given the variance in preferences employees have for how they structure and approach work. This is particularly relevant given the impact new technologies have had on how work is achieved by DOTs and the varying degree of comfort different populations have with those technologies. To achieve the vision for the 2030 U.S. transportation workforce, DOTs must work to resolve these many obstacles, which is best accomplished by leveraging the support of industry stakeholders who are pursuing similar goals. In the following section, potential industry partners are presented and described along with suggested guidelines for fostering relationships with these organizations.

III. Industry Stakeholders

This section contains two lists of industry stakeholders as well as commentary regarding the roles, responsibilities, and opportunities these stakeholders can participate in as part of building workforce capacity for career fields within transportation design, construction, and maintenance. These industry stakeholders are defined as organizations within state DOT networks who could support implementing strategic goals based on how they are currently impacting workforce trends, policies, and processes in the industry either intentionally or indirectly. The interrelationships between different agencies, policymakers, stakeholder groups, associations, and partners are also outlined in this section. Fostering partnerships with these key stakeholders will be critical to ensuring support for building a robust transportation workforce nationwide that extends beyond individual DOTs.

Identification of Industry Stakeholders

When identifying relevant industry stakeholders, both traditional and nontraditional stakeholders were considered. Many different organizations have traditionally partnered with state DOTs to support workforce development needs for design, construction, and maintenance jobs. However, there are also stakeholders who DOTs have not traditionally considered partners for the industry but who might provide valuable support in growing workforce capacity for these target occupations. These nontraditional partners may represent worker populations that typically

pursue jobs in design, construction, and maintenance, or they provide more generalized workforce development and staffing expertise across other industries.

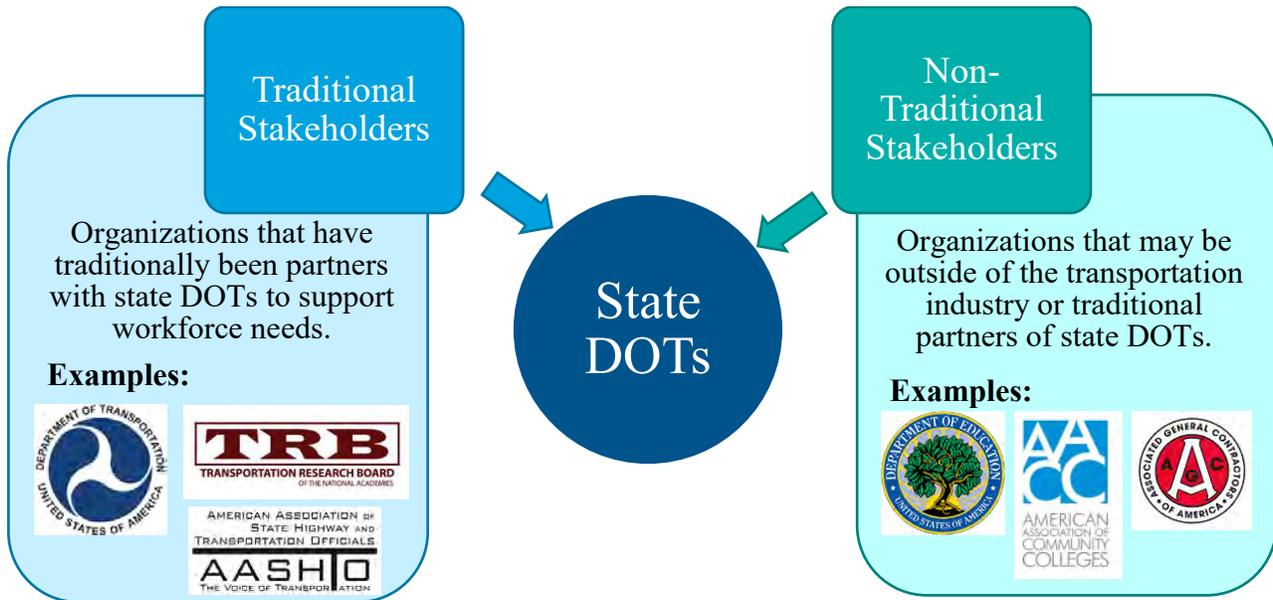


Exhibit L4 provides examples of industry stakeholders that would be considered traditional partners due to their emphasis on transportation-related issues, including a description of each organization. Exhibit 5 provides examples of stakeholders who would be valuable partners in building the future transportation workforce pipeline, but these stakeholders are not considered traditional partners as most have not played a direct role with DOTs in addressing transportation workforce issues.

| Exhibit L4. Examples of Traditional Industry Stakeholders for Partnership | |
|---|---|
| Organization | Description |
| The U.S. Department of Transportation (DOT)  | The mission of the U.S. DOT is to ensure our nation has the safest, most efficient, and most modern transportation system in the world, which improves the quality of life for all American people and communities, from rural to urban, and increases the productivity and competitiveness of American workers and businesses. This government agency oversees the Federal Highway Administration and ensures its policies and programs are aligned. |

| Exhibit L4. Examples of Traditional Industry Stakeholders for Partnership | |
|--|--|
| Organization | Description |
| <p>Federal Highway Administration (FHWA)</p>  | <p>The FHWA sees its role as one of providing national leadership, coordination, and assistance that support initiatives to develop and expand the professional capacity of the nation’s transportation workforce. From middle school education through ongoing professional development, the FHWA provides program support, technical assistance, and workforce development activities in partnership with federal, state, and local partners, industry organizations, schools, colleges and universities, and other education providers. FHWA’s workforce development programs seek to build awareness and interest in transportation career options; promote an understanding of how they positively impact our mobility, safety, and economic opportunity; and encourage professionals to take next steps in their careers through skills acquisition and enhancement. Many programs emphasize reaching women, minorities, and other disadvantaged groups.</p> |
| <p>Center for Transportation Workforce Development</p>  | <p>The Center for Transportation Workforce Development, an arm of FHWA’s Office of Innovative Program Delivery, leads initiatives seeking to enhance workforce development, ability, and diversity in key transportation sectors and disciplines. This organization supports five Regional Transportation Workforce Centers that facilitate partnerships between state DOTs and other industry stakeholder groups.</p> |
| <p>Transportation Research Board (TRB)</p>  | <p>TRB promotes innovation and progress in transportation through research. TRB facilitates sharing information on transportation practice and policy by researchers and practitioners, stimulates research, offers research management services that promote technical excellence, provides expert advice on transportation policy and programs, disseminates research results broadly, and encourages their implementation.</p> |
| <p>National Cooperative Highway Research Program (NCHRP)</p>  | <p>NCHRP is the program of TRB focused on sponsoring systematic, well-designed, and implementable research for the benefit of state departments of transportation administrators and staff. While NCHRP research is driven by challenges and opportunities at the State level, it is also tied to the national goals and aspirations of FHWA and the U.S. DOT.</p> |

| Exhibit L4. Examples of Traditional Industry Stakeholders for Partnership | |
|--|---|
| Organization | Description |
| <p>The American Association of State Highway Transportation Officials (AASHTO)</p>  | <p>AASHTO is a nonprofit, nonpartisan association representing highway and transportation departments in the 50 states, the District of Columbia, and Puerto Rico. Its primary goal is to foster the development, operation, and maintenance of an integrated national transportation system. AASHTO serves as a liaison between state departments of transportation and the federal government. AASHTO is an international leader in setting technical standards for all phases of highway system development.</p> |
| <p>National Highway Institute (NHI)</p>  | <p>NHI is the training and workforce education division of FHWA. This organization is committed to providing transportation professionals with high-quality training opportunities supplemented with adult learning research and using a variety of delivery methods (in-person, distance learning, blended). NHI is recognized as an accredited training provider by the International Association of Continuing Education and Training.</p> |
| <p>National Transportation Training Directors (NTTD)</p>  | <p>NTTD is a professional association of training and education professionals in the transportation industry. NTTD is a collaborative organization that improves the development and delivery of transportation training by sharing information, materials, delivery methods, contacts, and experiences.</p> |
| <p>Institute of Transportation Engineers (ITE)</p>  | <p>ITE is an international membership organization made up of transportation professionals including but not limited to transportation engineers, transportation planners, consultants, educators, technologists, and researchers. This professional association champions professional development through the sharing of educational resources, research, and recommended practices.</p> |
| <p>American Road & Transportation Builders Association (ARTBA)</p>  | <p>ARTBA is a transportation advocacy organization focused on growing and protecting transportation infrastructure investment to meet the public and business demand for safe and efficient travel. This membership organization has members from all sectors of the design and construction industry and offers networking and business development opportunities, training, news, research, and more.</p> |

| Exhibit L4. Examples of Traditional Industry Stakeholders for Partnership | | |
|---|---|---|
| Organization | | Description |
| National Association of County Engineers (NACE) |  | NACE is a professional membership association that strives to improve the transportation engineering profession at the county level through productive collaboration with industry stakeholders, the exchange of information and best practices, and legislative advocacy. |
| Women in Transportation International (WTS) |  | The mission of WTS International is to attract, sustain, connect, and advance women’s careers to strengthen the transportation industry as a whole. WTS offers its members mentoring and networking opportunities, scholarships, awards, and a variety of training and education programs and resources. |
| Transportation Diversity Council (TDC) |  | TDC is committed to providing world-class educational and development programs that promote diversity in the transportation and construction industries. TDC works toward this goal by engaging students of all ages and bridging the gap between these potential new employees and transportation professionals. |
| Conference of Minority Transportation Officials (COMTO) |  | COMTO is focused on ensuring opportunities exist in the transportation industry for minority individuals, veterans, and people with disabilities. COMTO accomplishes its mission by providing professional development activities, scholarships and internship funding, leadership training, and by engaging in political advocacy. |
| Garrett A. Morgan Technology and Transportation Education Program (GAMTTEP) |  | Administered by the FHWA, the GAMTTEP develops and delivers K-12 transportation-related curriculum and education enrichment programs with an emphasis on women and underrepresented groups. |
| National Summer Transportation Institute (NSTI) |  | NSTI is a program that focuses on science, technology, engineering, and mathematics (STEM) and exposes middle and high school students to transportation career opportunities, and encourages them to pursue transportation-related courses of study at the college and university level. |

| Exhibit L4. Examples of Traditional Industry Stakeholders for Partnership | | |
|---|---|--|
| Organization | | Description |
| American Society of Civil Engineers (ASCE) Student Chapters |  | The ASCE student chapter provides volunteer opportunities, leadership resources, mentoring, student chapter meetings, scholarships, contests, and competitions for students interested in the civil engineering profession. This chapter helps civil engineering and civil engineering technology students learn more about the industry and expand their network. |
| Associated Schools of Construction (ASC) |  | ASC is the professional association of construction educators and industry practitioners working together for the development and advancement of construction education. There are ASC student chapters at 143 four-year colleges and nine 2-year colleges, and these student chapters host regional competitions. |
| Construction Management Association of America (CMAA) |  | CMAA is a nonprofit, professional association that serves the construction management industry. CMAA’s local chapters offer opportunities for students to learn about construction projects in their community, network with members, and receive scholarship funding. |
| American Traffic Safety Services Association (ATSSA) |  | ATSSA is an international trade association that represents the road safety, traffic safety, and highway safety industry. ATSSA provides legislative advocacy, traffic control safety training, and a far-reaching member partnership. ATSSA offers a variety of experiential learning, training, and networking opportunities through its annual convention and traffic expo, mid-year meetings, and National Work Zone Awareness Week. |
| Local Technical Assistance Program (LTAP) |  | LTAP supports local and rural road agencies across the United States by providing training, technical assistance, and technology transfer services to help them manage and maintain their roadway systems. The program is a benefit to a local agency workforce challenged by limited access to training and technical assistance resources. |
| Tribal Technical Assistance Program (TTAP) |  | TTAP builds professional capacity within the federally recognized Tribes to support the management of their transportation assets. |
| Association of Pedestrian and Bicycle Professionals (APBP) |  | APBP is an association that brings together practitioners that want to make places more walkable and bikeable. APBP provides webinars, resources, scholarships, and a mentorship program to foster knowledge sharing and professional development of its members. |

| Exhibit L4. Examples of Traditional Industry Stakeholders for Partnership | | |
|---|---|--|
| Organization | | Description |
| Association of Metropolitan Planning Organizations (AMPO) |  | AMPO is an association dedicated to improving transportation in metropolitan regions across the United States. AMPO hosts an annual conference and symposium and shares publications and surveys with its members. |
| National Operations Center of Excellence (NOCoE) |  | NOCoE is a center that strives to provide resources and improve the transportation system management and operations community. NOCoE has an Operations Technical Services Program that encourages knowledge sharing and learning in the community, and a web portal that contains resources and discussion forums. |
| Dwight David Eisenhower Transportation Fellowship Program (DDETFP) |  | The DDETFP provides fellowships to students pursuing post-secondary degrees in transportation-related disciplines, encouraging future transportation professionals to seek advanced degrees, and helping to retain top talent in the U.S. transportation industry. |
| Intelligent Transportation Society of America (ITS America) |  | ITS America is an advocacy group dedicated to advancing research and deploying intelligent transportation technologies. ITS America offers memberships to students through student chapters at institutes of higher education and provides focused learning and networking opportunities for students considering Intelligent Transportation System careers. |
| International Municipal Signal Association (IMSA) |  | IMSA is a professional association that strives to improve the efficiency, installation, construction, and maintenance of public safety equipment and increase knowledge about traffic controls, radio communications, and related systems. IMSA publishes a journal about new technological advances and ideas in the public safety field, provides educational and certification programs, and hosts an annual conference. |

| Exhibit L5. Examples of Nontraditional Stakeholders for Partnership | | |
|---|---|--|
| Organization | | Description |
| The U.S. Department of Education (ED) |  | The U.S Department of Education promotes student achievement and preparation for global competitiveness by fostering educational excellence and ensuring equal access. This agency collaborates with the U.S. Department of Transportation and the Department of Labor to align career technical education with labor market needs. |
| The U.S. Department of Labor (DOL) |  | DOL fosters, promotes, and develops the welfare of the wage earners, job seekers, and retirees of the United States; improves working conditions; advances opportunities for profitable employment; and assures work-related benefits and rights. DOL’s labor projections inform various programs focused on building a strong workforce pipeline for the transportation industry. |
| American Association of Community Colleges (AACC) |  | AACC is an advocacy organization focused on advancing the interests of America’s community colleges. AACC facilitates partnerships with various stakeholders, including public and private transportation organizations interested in furthering relevant curricula and encouraging students to pursue a career in transportation. |
| Associated General Contractors of America (AGC) |  | AGC is an advocacy organization committed to advancing the interests of general contractors (including those working in transportation construction and maintenance). AGC sponsors a diversity and inclusion initiative, awards those who deserve to be recognized, and provides industry reports that further their profession. |
| National Association of State Personnel Executives (NASPE) |  | NASPE is an association that improves collaboration among state government personnel executives in the United States. This association shares knowledge and insights about human resources management with its members through regular meetings, publications, surveys, and discussion forums. |
| International Public Management Association for Human Resources (IPMA-HR) |  | IPMA-HR is an association that brings together the interests of public sector human resource (HR) professionals at all levels and strives to promote excellence in HR management. This association hosts forums for public sector HR professionals to interact, provides regular insights into issues unique to public sector HR, maintains an HR Policies Toolbox where members can receive guidance on creating policies, and has a job posting service. |

| Exhibit L5. Examples of Nontraditional Stakeholders for Partnership | | |
|---|---|---|
| Organization | | Description |
| Society for Industrial and Organizational Psychology (SIOP) |  | SIOP is the professional association for the science and practice of industrial-organizational (I-O) psychology, which is the field of psychology at work. SIOP supports I-O psychology research, provides forums to share findings and insights, identifies opportunities to expand and develop I-O psychology, promotes the education of I-O psychologists, and promotes public awareness of I-O psychology. This organization provides insights and guidance about work-related human behavior and hosts a network of workforce experts. |
| SkillsUSA |  | SkillsUSA is a career and technical student organization that prepares middle school, high school, and college students for careers in skilled trades. SkillsUSA supports over 370,000 students and instructors annually with training programs and resources. |
| American Society of Safety Professionals (ASSP) |  | ASSP is a global association of occupational safety professionals that advocates for safer work environments. It supports student chapters and provides scholarships, educational resources, and a student-focused Future Safety Leaders Conference. |
| Occupational Safety & Health Administration (OSHA) |  | OSHA is a large regulatory agency within the U.S. Department of Labor that offers a variety of safety-focused trainings and safety-focused internships for students. |
| American Public Works Association (APWA) |  | APWA is a nonprofit, professional association of public work agencies, private companies, and members who are dedicated to promoting professional excellence and public awareness of public works. |

Roles, Responsibilities, and Opportunities for Industry Stakeholders

The stakeholder organizations that are positioned to help build workforce capacity for transportation career fields are largely heterogeneous in their specific missions but equally important players in this industry framework. **National research organizations, professional membership associations, education and training organizations, labor unions, organizations that promote workforce diversity, and large federal agencies** all serve an important role in building the 2030 transportation workforce. While traditional industry stakeholder groups are relatively easy to call to mind (i.e., FHWA and AASHTO), an ideal framework should also encourage different stakeholders to work together toward common goals, as is the case with the **Highway Construction Workforce Partnership**, which is a coordinated effort between **FHWA, DOL, AGC, ARTBA, and AASHTO** focused on workforce development. By banding together with the common purpose of building the highway

construction workforce, these organizations share expertise via a constructive partnership to generate broader-reaching initiatives.

National clearinghouses and research organizations such as the **Transportation Research Board, Intelligent Transportation Society of America**, and **FHWA's Center for Transportation Workforce Development** have taken on the responsibility of advancing the transportation industry through the dissemination of relevant research and best practice information. The research and analysis these types of organizations fund and publish is intended to directly benefit the operations, infrastructure, and workplace practices of state DOTs. These organizations also play an important role in engaging transportation professionals around the nation and facilitating productive discourse for the benefit of the industry as a whole. An example of this is how the committee structure of **AASHTO** allows for sharing different perspectives, which goes on to inform the organization's policy recommendations around building workforce capacity.

Opportunities for improvement include a more concerted effort for research organizations like these to collect and share data among state and local transportation organizations. Another opportunity would be more active engagement between these kinds of organizations and other stakeholder groups such as membership associations and those focused on promoting diversity. These organizations should challenge themselves to consider unconventional partnerships more often as opposed to waiting for these arrangements to develop organically. Lastly, the input these research organizations receive from their constituents tends to be skewed toward the perspective of someone in a leadership position within their organization. Staff at all levels of the agency have valuable insights that could improve how DOTs engage in workforce planning efforts.

Highlight

More emphasis should be placed on collecting and voicing the opinions of mid-level and front-line staff on matters of workforce planning.

Professional membership associations are present at all levels of the transportation industry (local, state, national) and have assumed the responsibility of furthering the interests of their members, often through political advocacy. These interest groups also provide their membership base with a wide variety of benefits ranging from professional development and networking opportunities to training and educational resources. This combination of advocacy and membership services contributes to the capacity of transportation design, construction, and maintenance professionals to perform their duties now and into the future. For example, the **National Association of County Engineers** reviews federal transportation policy through a county-level lens to ensure this legislation does not have any adverse effects on local road safety plans. One opportunity for improvement here involves these organizations taking more of a multidisciplinary approach to advocacy and membership development. For example, the **Institute of Transportation Engineers (ITE)** is actively encouraging the inclusion of different academic disciplines into their university chapters as a way to add valuable perspectives beyond those just from civil engineering. Efficiencies can be created if an organization like ITE were to partner with another membership organization such as the **Association of General Contractors of America**. Such partnerships could even include the pooling resources to establish academies

and provide training or to accomplish other strategic goals benefiting all transportation professionals.

Organizations focused on **promoting and delivering training** to transportation professionals, like the **National Highway Institute** and the **National Transportation Training Directors**, are vital to building workforce capacity in the industry. Their intent is clear: to provide, coordinate, and/or improve the training and education transportation industry professionals receive to enhance how these professionals perform their work and develop throughout their careers. It is important to recognize that other organizations not singularly focused on providing training should also be included in partnerships as these organizations could help better support training across an industry-wide format. For example, **FHWA's Regional Transportation Workforce Centers** work with state DOTs to partner with local primary schools, community colleges, trade schools, and universities to guide students into transportation careers. These **Regional Transportation Workforce Centers** also help stand up technical certification programs. For example, the collaboration between **Colorado DOT** and **Front Range Community College** resulted in the creation of a construction management certification program. Room for improvement exists for training and education partnerships. Similar to a previous point, more emphasis should be put on surveying field-level staff and even students about possible training gaps and preferences of delivery methods. Additionally, these organizations might serve the future transportation workforce better by continuing to look for opportunities to learn from the private sector about advancements in adult learning course design and delivery.

The Conference of Minority Transportation Officials, Women in Transportation International, and the **Transportation Diversity Council** are all examples of industry groups focused on promoting diversity among the ranks of the design, construction, and maintenance workers. These organizations assume the role of educating the industry on the benefits of fostering a diverse, inclusive workplace as well as giving employers the support needed to attract and retain staff with different demographic backgrounds and work experiences. **FHWA's Summer Transportation Internship Program for Diverse Groups** takes things a step further by providing the opportunity for undergraduate, graduate, and law students to get hands-on experience working at the **U.S. DOT**, its modal administrations, and the state DOTs while learning more about transportation challenges and advancements. It is important for organizations promoting workforce diversity to partner with research groups, training and education organizations, membership associations, and large federal agencies as diversity is not only a "good thing," but it also translates into a robust, sustainable workforce that drives innovation in transportation. All workforce development initiatives, from training and education to understanding future industry challenges, can be strengthened by also identifying ways to promote all types of demographic diversity.

Large federal agencies such as the **U.S. DOT, U.S. Department of Labor (DOL), U.S. Department of Education (ED)**, and the **Occupational Safety & Health Administration (OSHA)** are also key role players in this industry-level framework. U.S. DOT, DOL, and ED often work together to align career technical education with labor market needs. This cooperation aims to equip students and non-students with the skills they need to be successful for in-demand career fields including highway design, construction, and maintenance. These federal agencies have joined together to host events like the **National Transportation Workforce Summit** and

continue to work together to build workforce capacity for transportation professionals. Still, more can be done to leverage the resources of these government agencies along with the perspectives and needs of other industry stakeholders. For example, DOL labor projections and ED grant programs could be better informed at the county level through partnerships with organizations such as the **National Association of County Engineers**. Knowledge shared by members of the **Associated Schools of Construction from foreign countries** could also prove insightful for both the DOT and ED. More open lines of communication (including data sharing) between large federal agencies and other stakeholder groups would build shared understanding and help each organization carry out their individual missions.

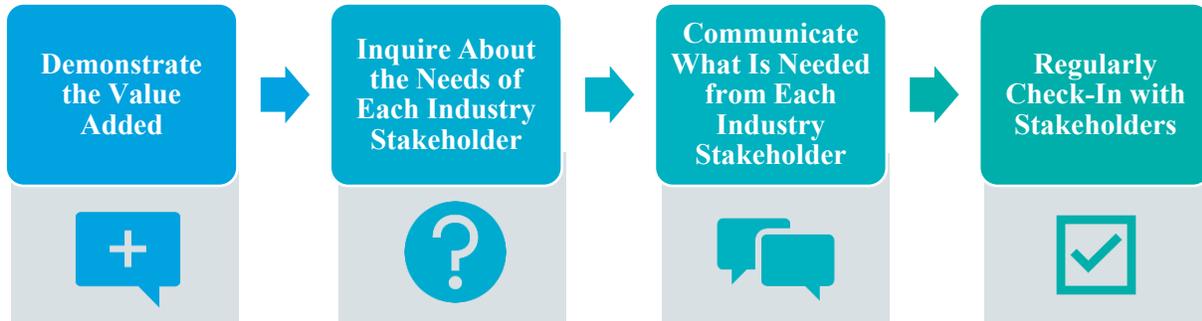
The stakeholder organizations featured in Exhibits L4 and L5 along with state DOTs around the country illustrate a vibrant transportation ecosystem that exists today. While some of the interconnections between stakeholder groups are strong and easy to see, many are yet to be solidified. Leaders of national clearinghouses and research organizations, transportation professional membership associations, training and education groups, organizations that promote diversity, and large federal agencies should constantly be looking for opportunities to forge new partnerships and share information for the sake of the future of transportation design, maintenance, and construction workforce. This is especially true for nontraditional stakeholder groups or those whose mission is not explicitly focused on building workforce capacity in the transportation industry but could contribute value, nonetheless. For example, to identify best practices and research perspectives related to workforce capacity-building, transportation organizations would benefit from partnering with experts in human capital, workforce development, organizational development, or human resources. Example organizations include the **Society of Industrial and Organizational Psychology (SIOP)**, **Society for Human Resource Management (SHRM)**, **National Association of State Personnel Executives**, and the **International Public Management Association for Human Resources**. These associations/membership groups are likely to offer perspectives external to the field of transportation and even bring in best practices and scientific learnings from other industries that could help transportation think more creatively and intentionally about how to build their talent pipeline for the future workforce. Training and education-oriented organizations and state DOTs alike could also learn from **SkillsUSA's** success where competitions have been used as a way to generate excitement for building specific vocational skill sets. Even a direct partnership with SkillsUSA could provide powerful untapped resources for orienting young people toward careers in design, construction, or maintenance. These few examples demonstrate that more can be done to create logical links between these stakeholder organizations.

IV. Process

This section provides strategic guidance on the building blocks (i.e., foundational components) to establish a community of influencers that could support a robust 2030 transportation design, construction, and maintenance workforce. Further, an industry-level change management approach is described within this section to be used as the underlying mechanism to achieve this vision for the 2030 workforce.

Setting the Stage

The following steps should help guide the development of relationships between key industry stakeholders and DOTs.



Step 1: Demonstrate the Value Added



Relationships between key industry stakeholders and DOTs may be fostered by first demonstrating to industry stakeholders how they have the opportunity, and perhaps the responsibility, to join forces with DOTs to build talent pipelines. DOTs should also explain how fostering relationships with one another will be mutually beneficial as these organizations are often working toward similar goals (e.g., creating a robust talent pipeline in the transportation industry). Other benefits to growing these connections may include an increase in each organization's return on investment if they are able to collaborate on events or initiatives and share financial burdens, greater generation of ideas to address common industry challenges, and a mutual support system for implementing new ideas or starting new interventions.

Step 2: Inquire About the Needs of Each Industry Stakeholder



After communicating the many benefits of fostering these partnerships with key industry stakeholders, it is important for DOTs to ask the industry partners what their needs are to ensure the eventual partnerships result in mutual benefit. As the DOTs and their industry partners are often working toward like goals, fulfilling the needs of the industry stakeholders is almost certain to help DOTs as well and encourage these partners to engage with DOTs moving forward. For example, a local university or other academic institutions may indicate a need for internship opportunities for their students, which DOTs may very likely be able to support. Designing internship opportunities allows these universities to funnel their students from academia into the workforce and helps create a pipeline of talent for the DOTs.

Step 3: Communicate What Is Needed from Each Industry Stakeholder



For these relationships to be mutually beneficial, it is imperative that DOTs communicate the specific forms of support that are needed from each industry partner. This step is needed so that industry partners are aware of specific areas to focus their efforts. For example, DOTs may communicate to local universities or other academic institutions that they need students to enter the workforce with a basic understanding of the purpose for multi-modal perspectives and design

knowledge for those various mode, and that this information needs to be covered within their required curriculum.

Step 4: Regularly Check-In with Stakeholders



To maintain healthy beneficial working relationships with their industry partners, DOTs must keep in regular communication with their partners. This will provide both the DOTs and the industry partners opportunities to express additional needs, satisfaction with the types of support provided, and plan for future workforce initiatives.

Incorporating an Industry-Level Change Management Approach

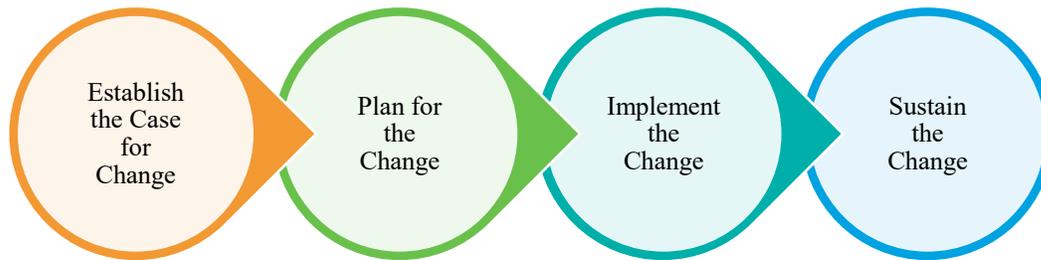
As the transportation industry moves from a solitary perspective on workforce capacity-building—where individual DOTs are fighting to fill positions in “emergency mode”—to a strategic, industry-wide approach that involves multiple partners, proactive planning (5 to 10 years out), and initiatives that focus agencies and their workforce to approach workforce development from a broader perspective, the status quo will be challenged and the need to change, as well as the resistance to change, will be inevitable. Thus, it is important that transportation stakeholders approach this shift to broader, collaborative thinking and planning through a methodological change management lens. Using a change management approach will increase buy-in to changes, help to identify champions for change, and allow the partnerships to move with more fluidity and result in more efficient and effective techniques for building the talent pipeline.

Change management can be described as the “systematic approach and application of knowledge, tools and resources to deal with change. It involves defining and adopting corporate strategies, structures, procedures and technologies to handle changes in external conditions and the business environment.”⁵ When implementing a change management approach, the overarching goal is to “successfully implement new processes, products and business strategies while minimizing negative outcomes.”⁶ As DOTs and their industry partners prepare to work toward a shared 2030 workforce vision, it is important to carefully follow a change management approach to ensure changes are mission-aligned, supported by leadership, and sustainable. The following graphic summarizes a change management approach to partnership.

⁵ Society for Human Resource Management (SHRM) Glossary of Human Resource Terms. n.d. <https://www.slideshare.net/freeKhan/glossary-of-human-resources-management-terms>. Accessed on October 15, 2019.

⁶ Managing Organizational Change. n.d. Society for Human Resource Management (SHRM) Toolkits. www.shrm.org.

Change Management Approach



To **establish the case for changing**, DOTs and their industry partners should define what is changing and why, the business impact of a change, and their expectations for the scope of the change. As a part of this step, they should identify the required resources for the change, the roles the DOT and the industry partner will take in implementing the change, the change timeline, and metrics for measuring the success of the change.

To **plan for the change**, DOTs and their industry partners should work to understand how the change will impact their organizations and create a strategy to help them prepare and adapt to this impact. At this step, DOTs and their industry partners should also identify any potential obstacles to implementing the change and work to mitigate those risks. They should also develop communication plans for presenting the change to their employees and other potential stakeholders (e.g., their community).

To **implement the change**, DOTs and their industry partners should utilize the communications created in the previous step to catalyze the change. DOTs and their industry partners should also monitor any obstacles and/or resistance to the change and use the strategies created in the previous step to limit resistance.

Finally, DOTs and their industry partners should work to **sustain the change** by tracking the implementation of the change, employees' response to the change, the success of the change (e.g., response from future workers/external labor market), and resistance to the change. It is important that DOTs and their industry partners are open to making improvements to the change to better meet their objectives.

V. Planning

Goals and Actions to Achieve the Vision

This section provides examples of strategic goals and action steps that transportation industry stakeholders might reference to guide industry and community influencers toward achieving a shared vision for building a solid 2030 transportation design, maintenance, and construction workforce. These goals and action steps aim to address industry gaps and the roles of the key stakeholders and partners previously described in this framework. Along with the strategies presented herein, DOTs must develop their own specific goals and actions tailored to their

current and future workforce needs that will leverage partnerships with industry-wide stakeholders to achieve those DOT-specific goals.

Example Goal 1: Create a knowledge forum to promote knowledge sharing between stakeholders.

Action: Develop a knowledge-sharing forum to promote knowledge sharing to collaborate on best practices in marketing and external communication.

Description: A knowledge-sharing forum can be used as a tool for discipline intersection, unity between stakeholders and contractors, and to facilitate conversation and communication on best practices regarding the workforce life cycle. A knowledge-sharing forum is a space in which individuals come together and share knowledge and information on relevant topics. They can provide in-depth, instant, and on demand information that can help address barriers within and across an industry. There are many ways a knowledge-sharing forum can be structured. One type of knowledge-sharing forum is a Community of Practice (CoP), which is a collection of people who discuss concerns, knowledge, and ideas about a shared topic of interest. CoPs are structured forums where members are invited to participate, attend regular meetings (e.g., once a month, once a quarter, or twice a year), and have a structured communication channel (e.g., mailing list, Teams channel, SharePoint website). DOTs and stakeholders might use a knowledge-sharing forum, like a CoP, to provide information, share ideas, and develop strategies on ways to better communicate needed jobs to reach a wider audience.

Interviews with industry stakeholders raised the issue of not being able to find viable talent for key industry positions, such as mechanics and engineering. Knowledge-sharing forums could be a useful tool to store information such as policies, procedures, and guidelines on recruitment strategies, best practices, and marketing ideas to attract new employees. This type of forum could be created for cross-company knowledge sharing to foster communication and be a catalyst for industry stakeholders to operate together. Additionally, a knowledge-sharing forum could address the challenges around recruiting, retaining, and engaging staff members for key industry positions.

Action Items



- Initiate the knowledge forum, determine its purpose, and identify individuals and/or organizations who would benefit from and contribute to the knowledge forum’s purpose. Doing so accomplishes the goal of starting a forum and bringing people together to improve collaboration.
- Establish knowledge forum logistics, including the communication platform (e.g., email list, SharePoint website, Teams channel), method of dialogue (e.g., virtual or in-person brown bag sessions, blog posts), and meeting frequency (e.g., monthly, quarterly, annually). Solidifying these characteristics will ensure the forum is effective in collecting, storing, and sharing knowledge.
- Coordinate (rotating) facilitators who will maintain and manage the knowledge-sharing forum. Establishing roles for the knowledge-sharing forum will help the forum accomplish its goals long term.
- Select core elements of the knowledge base (e.g., a pre-designed knowledge base foundation).

Example Goal 1: Create a knowledge forum to promote knowledge sharing between stakeholders.

| | |
|---|--|
|  | <p>Resources</p> <ul style="list-style-type: none"> ▪ Becoming a Knowledge Sharing Organization by the World Bank Group⁷ ▪ Best Practices in Knowledge Management by Hanover Research⁸ ▪ The Design and Implementation of Effective Knowledge Management Systems by the Mack Institute for Innovation Management⁹ |
|---|--|

Example Goal 2: Align employee skills with DOT needs.

Action: Create networks that help support current workforce development efforts.

Description: As technology continues to advance and demands on the transportation industry continue to rise, DOTs and industry stakeholders can establish and expand their networks to engage larger and more diverse audiences in programs and initiatives that support current employees and help recruit qualified applicants for the future. Rather than multiple agents working independently on the same problem, these networks have the potential to achieve industry-wide impact by establishing a framework that promotes the coordination of effort and resources across the industry and between stakeholders. These networks also have the ability to develop ties within and across communities to build trust, cooperation, and a shared vision that inspires people to take collective action toward a common goal. Examples of how networks support current and future employees include organizing industry-day events at career days and producing joint curriculum materials for educational, vocational, and technical programs.

| | |
|---|---|
|  | <p>Action Items</p> <ul style="list-style-type: none"> ▪ Leverage networks that DOTs, stakeholders, and employees already have to decide on partnerships. ▪ Establish organizations to develop networks with (e.g., vocational programs, workforce boards, educational institutions). ▪ Evaluate the networks annually (e.g., determine if more members are needed, if goals and expectations were met, and whether some goals and expectations need to be modified). |
|  | <p>Resources</p> <ul style="list-style-type: none"> ▪ Boeing Partnership Programs by Everett Community College¹⁰ ▪ AASHTO Partnership Organizations by AASHTO¹¹ ▪ National Transportation Training Directors List of Partnering Organizations¹² |

Example Goal 3: Promote data sharing between DOTs and industry partners.

Action: Develop a joint data management and sharing policy.

⁷ <https://openknowledge.worldbank.org/bitstream/handle/10986/25320/9781464809439.pdf>

⁸ <https://www.gssaweb.org/wp-content/uploads/2015/04/Best-Practices-in-Knowledge-Management-1.pdf>

⁹ https://mackinstitute.wharton.upenn.edu/wp-content/uploads/2013/01/2005_2006_Morrissey_Steve_The_Design_and_Implementation_of_Effective_Knowledge_Mgmt_Systems.pdf

¹⁰ <https://www.everettcc.edu/ccec/boeing>

¹¹ <https://meetings.transportation.org/sponsors-partners/>

¹² <http://nttdonline.net/>

Example Goal 3: Promote data sharing between DOTs and industry partners.

Description: The development of a data management and sharing policy can promote transparent, consistent sharing of relevant data between DOTs and industry partners. Understanding the “rules of use” and agreeing on the way to manage data helps to make a more seamless, productive exchange between partner organizations. Interviews with industry stakeholders emphasized the lack of available data as it relates to recruitment and retention strategies, which limits outreach to potential candidates and limits the retention of highly skilled employees. Other industry stakeholders mentioned they lack data that would inform how to best attract, recruit, and retain younger employees, as well as data to better help human resource managers know where to target their efforts. A joint data management and sharing policy between DOTs and industry stakeholders would specify what data should be shared as well as protect the interests of those who developed it. Examples of data that could be collected and shared include needs assessment data; benefit numbers (participation in offerings, satisfaction with specific benefits); compensation data; and employment trends by regions, demographics, and other relevant factors. The policy could outline how to interpret the data, guidelines on what data are considered confidential, who can access the data, how investments will be made by each partner to gather and manage the data, and boundaries for each organization on what data can be shared with the public. Most importantly, a joint data management and sharing policy will illuminate the value of establishing relationships to interpret, store, and process relevant and available data. This policy could be the first step to promote data sharing among industry partners and begin to fill in gaps that individual industry stakeholders are wrestling with now.

| | |
|--|---|
| <p>Action Items</p>  | <ul style="list-style-type: none"> ▪ Determine the data management and sharing platform. ▪ Establish instructions for users of the data management and sharing platform. ▪ Communicate about the data management and sharing platform to the workforce, including its purpose, location, and how to use it. ▪ Develop a data organization system (e.g., log new data entries in a spreadsheet). |
| <p>Resources</p>  | <ul style="list-style-type: none"> ▪ Labor Market Data by EMSI¹³ ▪ Labor Market Data by Burning Glass¹⁴ ▪ Benefits of developing a data management and sharing policy by Destination CRM¹⁵ ▪ Transportation Industry Workforce Statistics by the U.S. Bureau of Labor Statistics¹⁶ |

Example Goal 4: Support collaboration with local workforce development boards.

Action: Create a partnership collaboration toolkit.

¹³ <https://www.economicmodeling.com/>

¹⁴ <https://www.burning-glass.com/products/labor-insight/>

¹⁵ <https://www.destinationcrm.com/Articles/Web-Exclusives/Viewpoints/4-Clear-Benefits-of-a-Strong-Data-Governance-Policy-122809.aspx>

¹⁶ <https://www.bls.gov/iag/tgs/iag48-49.htm>

Example Goal 4: Support collaboration with local workforce development boards.

Description: A partnership collaboration toolkit is a document that outlines the standard operating procedures and essential components of partnerships with outside organizations. This toolkit could describe key features of collaboration with external partners, such as identifying personnel to manage and oversee the partnerships, establishing goals for partnerships, and determining the terms and conditions of partnerships. This toolkit could be particularly useful for DOTs and stakeholders who have identified potential partners but want to learn more about how to effectively manage the partnership.

Partnerships with outside organizations can occur in many forms, formats, and relationships. For example, partnerships between DOTs and local education providers could allow students to gain exposure to transportation-related activities while simultaneously developing the knowledge, skills, and motivation that DOTs require to meet their workforce needs (Cronin et al. 2013). These programs can also help retain future staff by providing potential applicants with a glimpse of their career advancement in the workplace. Providing early insight into their potential career advancement can increase younger employees’ interest, loyalty, and commitment to the company should they begin working there. By involving the community and creating these pathways to employment, DOTs will be better able to recruit and retain staff. Creating a partnership collaboration toolkit will provide DOTs’ stakeholders with the tools and guidance to establish these partnerships and ultimately improve DOTs’ ability to recruit and retain staff.

| | |
|--|--|
| <p>Action Items</p>  | <ul style="list-style-type: none"> ▪ Describe the necessary characteristics of a partnership, including selecting people to oversee the partnership, setting goals and expectations, evaluating the partnership, and adjusting goals as needed. ▪ Consolidate information into an accessible document so the material can be easily understood by various audiences. ▪ Publicize the partnership collaboration toolkit to appropriate audiences. ▪ Incorporate changes and suggestions as individuals use the toolkit so it can be improved. |
| <p>Resources</p>  | <ul style="list-style-type: none"> ▪ Partnership Self-Assessment Toolkit¹⁷ ▪ Transportation Coordination Resources¹⁸ ▪ Kansas Rural Transit Providers Fact Sheet¹⁹ ▪ TCRP Report 101: Toolkit for Rural Community Coordinated Transportation Services²⁰ |

Example Goal 5: Develop a broader understanding of employee needs and capabilities.

Action: Create topic-specific webinars to foster employee collaboration and knowledge sharing.

¹⁷ https://aims.uw.edu/care-partners/sites/default/files/LHAZ_Partnership_selfassessment_toolkit.pdf

¹⁸ <https://nationalcenterformobilitymanagement.org/by-topic/coordination/>

¹⁹ <http://www2.ku.edu/~kutc/pdffiles/FS-thinkingoutsidebox.pdf>

²⁰ <https://www.nap.edu/catalog/13751/toolkit-for-rural-community-coordinated-transportation-services>

Example Goal 5: Develop a broader understanding of employee needs and capabilities.

Description: A webinar is an online platform where web-based content (e.g., presentation slides, videos) is shared in real time with numerous attendees. The main purpose of webinars is to develop an inclusive space to share knowledge with a large group of people in a cost-effective manner. Industry stakeholders can use webinars as a platform to promote employee collaboration to develop a broader understanding of their needs and abilities. This also gives DOTs the opportunity to not only collaborate with other industry stakeholders on emerging topics in the industry but to also share industry-related materials on specific topics and expand their reach of collaboration with DOTs they have not had the opportunity to work with. This platform also fosters increased involvement from DOTs by storing and hosting information in an online platform to make the information accessible to all.

Action Items



- Determine webinar hosts and audience to ensure the webinar is effectively organized and appropriate members are included.
- Solidify webinar goals, content, and format (e.g., single speaker, interviews, panel discussion, open Q&A) so the webinar has a clear purpose and content is effectively conveyed.
- Select webinar medium (e.g., Zoom, Adobe Connect, WebEx, Teams) and frequency (e.g., once a month, once a quarter, once a year).
- Publicize and promote the webinar through emails, social media, and websites so it reaches relevant audiences.

Resources



- [FHWA Presentations and Webinars](#)²¹
- [U.S. Chamber of Commerce Tips for Hosting Webinars](#)²²

Example Goal 6: Prepare future employees for work in construction, design, and maintenance careers.

Action: Develop industry days with local schools, technical programs, and associations.

Description: Industry days are events that bring together various stakeholders to advertise the field, host discussions, and recruit potential employees. Unlike job fairs, industry days are designed to introduce people to “hands-on” tools and tasks performed in the field and to extend networks (Cronin et al. 2011). To better prepare future employees for work in construction, design, and maintenance fields, DOTs could collaborate with local schools, technical programs, and associations by jointly hosting industry days. Doing so will bring DOT staff, educators, students, and associate members together to have dialogues about the future of the field and improve collaboration across related industries. In particular, DOTs could partner with associations, like Women in Transportation International (WTS) or Alaska Native Science and Engineering Program (ANSEP), to improve inclusion and diversity while also better preparing future employees for construction, design, and maintenance careers. Hosting career days with local schools, technical programs, and associations will not only improve relationships with outside organizations but also provide networks that can better prepare future employees for work in construction, design, and maintenance.

²¹ <https://www.fhwa.dot.gov/tpm/resources/presentations.cfm>

²² <https://www.uschamber.com/co/grow/marketing/how-to-host-webinars>

Example Goal 6: Prepare future employees for work in construction, design, and maintenance careers.

Action Items



- Identify and reach out to educational institutions and associations that would benefit from, and be interested in, cohosting an industry-day event.
- Collaborate with the educational institutions and associations while planning the event, including when inviting speakers, organizing activities, and planning networking events.
- Publicize the event to current employees and students of partnering organizations through emails, posters, websites, and social media.
- Host industry-day event, then evaluate its success with achieving its intended goals and make changes as needed for the next event.

Resources



- [American Public Transportation Association \(APTA\) Career Days](#)²³
- [Rhode Island Construction Career Days](#)²⁴
- [Pierce County Career Day](#)²⁵

VI. Moving Ahead

The primary intent of this Industry Framework is to remind transportation stakeholders that the challenges related to workforce capacity-building for transportation design, maintenance, and construction are often not unique to their single organization. Further, this Framework seeks to emphasize the value of partnerships and collaboration in the process of attacking workforce needs from an industry-wide, “we are in this together,” and “what benefits one of us, benefits us all” mentality. By working to create a unified 2030 Vision for Workforce Capacity-Building across these three disciplines, transportation stakeholders will begin to unveil an approach that is certain to transform how the entire industry attracts and grows new talent. A shared 2030 Workforce Vision will also serve to increase the visibility of transportation as a place for longtime career success, growth, and positive impact. The partners called out within this brief document as well as the example goals mentioned are simply the tip of the iceberg. The intent is that this document will stimulate thinking about and seeking of partnership opportunities both within and outside transportation particularly related to workforce development and that these partners will continue to identify new goals and innovative ways to pool resources for the greater good of the industry and its future workforce.

Appendix M. Protocol for Task 8 Strategy Working Sessions

Introduction

²³ <https://www.apta.com/research-technical-resources/aptau/industry-resources/national-workforce-programs/educational-youth-and-student-programs/apta-national-public-transportation-career-day/>

²⁴ <http://ciri.net/2019/06/12/construction-career-days-3/#:~:text=RI%20Construction%20Career%20Days%20is%20now%20a%20biannual%20event.&text=Beginning%20in%20Fall%202019%2C%20this,day%20event%20an%20educational%20success.>

²⁵ <https://www.constructioncenterofexcellence.com/events/pierce-county-career-day>

Hi, I am [insert name] from ICF, and I will serve as the facilitator to today's session. Welcome and thank you for serving on this important panel for NCHRP Project 02-25. Given your valuable expertise, we wanted to engage you in this working session. We intend for this session to last approximately 90 minutes. Thank you for participating.

To date, we have been conducting research on workforce capacity-building for the transportation design, construction, and maintenance disciplines. We also have [recorder name] on the call who will be taking notes on our conversation to help us easily review our discussion and make updates to the strategies as needed.

The purpose of today's working session is to discuss a selection of strategies our research has identified as impactful to helping build capacity in DOTs in the three occupational areas mentioned. The intent of this project has been to help DOTs identify challenges and then outline detailed, effective strategies for building a sustainable highway design, construction, and maintenance workforce. Today, we will focus on the draft strategies I sent you in advance of this session. Please, be aware those strategies still need to undergo a detailed QC process. For now, let's focus on walking through the strategies at a high level, and then, I will present a series of questions to elicit your expertise in specific places where we need to further refine the strategies.

Background

Before we start the working sessions, I would like to give a brief background of what we have done to date on this project, which helps to explain how we arrived at these specific strategies. [Show PowerPoint slide of project trajectory]

This project consists of nine tasks with the overall objective of developing practical strategies and tools to improve how state DOTs recruit, select, train, and sustain a capable workforce over the next 10+ years in light of significant labor market shifts, competitive forces, and broad industry changes.

The tasks were broken into two phases, and an overview of each task is as follows:

- Task 1: Literature review and background research to identify workforce trends, available training and education, and organizational policies.
- Task 2: Interviews and focus groups to identify workforce challenges, future-state, and best practices.
- Task 3: Survey of state DOTs for priority jobs, challenges, the future state of the Priority Jobs, and related best practices.
- Task 4: Labor market analysis for Priority Jobs.
- Task 5: Interim report of Summary of findings in Phase 1.
- Task 6: Development of Future Industry Scenarios.
- Task 7: Development of a Roadmap that outlines effective human capital strategies.
- **Task 8: Guides for developing and establishing a qualified design, construction, and maintenance workforce into 2030 and beyond.**
- Task 9: Final report and presentation.

We will not have time to dive into each of the previous tasks conducted on this project, but please review the quarterly progress reports we submitted to Senior Project Officer for more detail on the work we have performed thus far.

Are there any questions before we get started?

Questions

[**Note to facilitator:** Take 1–2 minutes to summarize the gist of the strategy first before asking questions so they have a clear understanding of the main points of the strategy (i.e., what the strategy is trying to get at, what industry challenge the strategy is intending to address).]

Strategy

1. How could this strategy be improved to ensure it is feasible for most DOTs to implement in the next 5–10 years? What specific aspects of this strategy will be more difficult for smaller DOTs to implement? What are some alternative approaches these smaller DOTs could leverage to achieve a similar outcome to what is intended by this strategy?
2. How could this strategy be improved to help solve the [related industry challenge] given what DOTs are facing in this area?
3. What additional elements should be included in this strategy to refine it further and provide greater clarity for DOTs to use and implement in the future?
4. Could you please give an example of how this strategy would be applicable to each of the transportation disciplines of focus for this project: design, construction, maintenance?
[Note to facilitator: Explain we are looking for clear ways the strategy would vary for each of these fields either in terms of how the DOT would implement, jobs specifically impacted by the strategy within each discipline, and/or a brief case study that explains how a DOT used this strategy in real life to address something specific to each of these disciplines? E.g., “ABC DOT did this related to transportation construction to help attract more construction workers.”]
5. What additional target audiences should be included for this strategy?
6. What are key personnel or stakeholders within a DOT that should be called on to help implement this strategy? [For example, if this strategy were about improving corporate benefits, it might be important to have the HR Director as a lead but also have a representative from each division in the company serve on a team of champions to give voice to what the employees want.]
7. What are the potential challenges a DOT might face when trying to implement these strategies?
 - a. Do you foresee any additional implementation steps that should be listed in the action steps to help overcome these obstacles?
8. What additional resources or support might a DOT need to achieve the desired outcomes of this strategy?
9. What are some examples of similar types of initiatives other DOTs are implementing that relate to this strategy? What are some lessons learned you have witnessed that would be relevant to this strategy?

10. What additional comments would you like to add about this strategy before we move on to the tools?

Tools

How might we refine—simplify or enhance—this tool or create an additional tool to help guide a DOT to implement this strategy?