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Help Wanted: People, Organizations, Jobs, and Businesses for Tomorrow’s Transportation
Andrew C. Lemer

Finding ways to attract, develop, and retain transportation-sector employees and contractors—ensuring that agencies and the sector as a whole can count on the workforce needed for the future—presents major challenges that TRB has been working to help define and address through research and support for public policy development. AASHTO, modal administrations of U.S. DOT, and other TRB partner organizations are actively engaged as well. Articles in this issue of *TR News* describe how practitioners and educators are assessing changing demographics and technology to estimate transportation workforce needs and develop practical strategies and tactics for meeting those needs.

View from the Top: The Future Multimodal Workforce
Candace Blair Cronin and Lawrence D. Goldstein

Research conducted under TRB’s Cooperative Research Programs and other organizations points the way to a cross-modal perspective on developing human capital. A lack of strategic thinking and intentional action on workforce development have led to shortages of workers in the trades, competition for workers with skills and training to work with new technologies, an overemphasis on four-year university programs as a hiring qualification, and culture clashes across a multigenerational population of employees. The authors describe common workforce challenges, important variations in workforce issues among transportation modes, and emerging perspectives on the value of building an integrated, strategic approach to workforce development.

Silver Lining for the Transportation Workforce: Research Points a Way Forward
Candace Blair Cronin and Lawrence D. Goldstein

How to Win the War for Talent
Charlene McArthur

A coming wave of retirements across the transportation workforce—along with technological advancements and generational differences among employees—affects every industry, and the battle for talent is fierce. An organization’s success depends on its workers; the ability to hire new people and keep quality people is an essential indicator of an organization’s success. This article examines workplace culture, flexibility, and other expectations of new workers and job seekers; explores what drives those expectations; and presents best-practice, experience-based strategies to improve attraction and retention.

Building a Business Case for Increasing Diversity in the Transportation Workforce
Stephanie Ivey, Meredith Powers, and Adriana Clark

Statistics show there is still progress to be made in the pursuit of gender and ethnic diversity among transportation workforces. Agencies and contractors cannot afford to accept the status quo—as the authors prove in this article, recent studies indicate that organizations with the most diverse workforces reap the rewards of increased efficiency, innovation, and profitability. Fostering diversity in the transportation industry is essential for agencies to achieve their mission but also can improve performance. The impacts of changing demographics, technology, and user needs make it crucial to attract a highly skilled and diverse workforce, ensuring that the nation remains at the forefront of innovation.

The Future Is Now: Transportation Agencies and Their Capabilities
Frances Harrison and Hyun-A Park

Connected and automated vehicles, new information technologies, funding instability, transportation system management and operations (TMSO), and transportation system resilience are some of the current and future challenges of transportation agencies across the country. Presented in this article is an NCHRP project on ensuring essential capabilities for transportation agencies of the future, to help DOTs anticipate and adapt. Project objectives include identifying and describing emerging issues and trends, engaging senior agency leadership in discussion, and providing guidance on strategies to understand and meet upcoming challenges.
32 Job Openings for Transportation System Management and Operations: Delivering TSMO Services

Todd Szymkowski and Stephanie Ivey

Increased TSMO focus by transportation agencies demands not only recruitment and retaining efforts for traditional engineering positions but also for more technically diverse workforce with expertise in supporting emerging technologies such as connected and automated vehicles, big-data analytics, and sophisticated decision support systems. Authors outline an NCHRP project that provides DOTs and other transportation agencies with usable materials for revamping TSMO hiring and knowledge development, as well as lessons to meet other workforce needs associated with new technologies.

37 Maintenance Peer Exchange Supports Workforce Development Efforts

Kathryn Zimmerman

Highway maintenance workers must perform a remarkable range of duties. They also must be flexible as tasks change priority and must be able to operate a wide range of often-complicated equipment. Across the country, however, state DOTs report that filling highway maintenance positions is their biggest workforce challenge. Enter the Midwest Transportation Workforce Center, which developed a vision to better understand and address the need for workers.

45 Supporting Workforce Continuity: Minnesota Department of Transportation’s Knowledge Books

Nancy Daubenberger

Several sections of the Bio Bridge in Concepcion, Chile, collapsed after a 2010 earthquake. An NCHRP project assessing, marking, and coding highway structures in emergencies is featured in the November–December issue of TR News.

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TR NEWS

features articles on innovative and timely research and development activities in all modes of transportation. Brief news items of interest to the transportation community are also included, along with profiles of transportation professionals, meeting announcements, summaries of new publications, and news of Transportation Research Board activities.

TR News is produced by Transportation Research Board Publications Staff Eileen P. Delaney, Director of Publications Heidi Willis, Associate Editor Jennifer G. Correro, Assistant Editor

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Editorial Correspondence: By mail to the Publications Office, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, by telephone 202-334-2986, by fax 202-334-3495, or by e-mail icamarda@nas.edu.

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The transportation sector of the U.S. economy employs millions of people—not only in the movement of goods and people, but also in the design, construction, operation, and maintenance of a vast system of transportation infrastructure. This infrastructure, which includes roads, airports, waterways, ports, harbors, rail facilities, and pipelines—with an estimated overall value of more than $5 trillion in 2014, or more than $16,000 per person—has an outsize influence on well-being and quality of life by providing essential access and mobility for work and businesses, health care, education, recreation, and public safety services. The system itself is developed, operated, and managed by private and public enterprises and, as of 2012, employs approximately 4.3 million people. This number is even larger when it accounts for people whose jobs are entirely dependent on the transportation system, from delivering fresh lettuce year-round to a fast response to a fire alarm to the reliable delivery of children to school in the morning.

Increasingly, managers and administrators throughout the transportation system feel concerned that not enough people are available to fill these jobs. A growing number of older workers are approaching retirement; at the same time, rapid growth in other areas of the economy offer high wages and attractive working conditions to new entrants to the labor force. For example, a 2018 survey of 2,700 contractors and construction managers found that 91% of respondents reported having a difficult or moderately difficult time finding skilled workers. Conversations with the leaders of many government transportation agencies yield a similar assessment.

Finding ways to attract, develop, and retain employees and contractors to ensure that transportation agencies and the sector as a whole will have the workforce needed for the future presents major challenges. Through research and support for public policy development, the Transportation Research Board (TRB) works to define and address these challenges.

The American Association of State Highway and Transportation Officials,
modal administrations of the U.S. Department of Transportation, and other partner organizations of TRB are actively engaged as well. Articles in this issue of TR News describe how practitioners and educators are assessing changing demographics and technology to estimate transportation workforce needs and to develop practical strategies and tactics for meeting those needs.

**Refreshing the View**

Candace Blair Cronin and Lawrence Goldstein make the case that transportation agencies need to adopt a cross-modal view of their workforces and a strategic approach to developing those workforces. Many of the skills and competencies needed to manage the future transportation system are not restricted to highways, rail, or airports; old stereotypes of who can do the jobs must be discarded for agencies to attract talented, capable people. Charlene McArthur suggests that, to succeed, transportation organizations must reach out to younger students and focus on workplace culture.

Among the more pernicious stereotypes to be confronted is the human tendency to associate only with people like oneself. A wide range of research shows just how valuable it can be to have a diverse set of perspectives and appropriate skills within any group that has a mission to accomplish or problem to solve. Stephanie Ivey, Meredith Powers, and Adriana Clark describe the business case for increasing the diversity of the transportation workforce.

Another stereotype is the inclination to think of workforces simply as sources of labor. An organization’s workforce—its employees and contractors—comprise a reservoir of experience, judgement, and knowledge. This reservoir is a valuable asset, a form of capital that can be lost or allocated poorly to mission-critical activities. Frances Harrison and Hyun-A Park describe some of the efforts to combine and apply knowledge management and human resources development to ensure that transportation agencies have the essential capabilities to pursue their missions. Nancy Daubenberger and Kathryn Zimmerman each provide examples of specific applications of these practical management tools.

**Harnessing Technology**

Developments in technology are high on the list of change agents in transportation workforces. It remains to be seen how quickly and extensively driverless vehicles, for example, or the replacement of fossil fuels as primary sources of energy—as well as the introduction of sensors, integrated circuits, and other microelectronics into many aspects of transportation system operations—have progressively changed the job descriptions and educational backgrounds of large groups within transportation workforces.

Todd Szymkowski and Ivey describe how one of these groups—professionals dealing with transportation system management and operations—is coming to grips with the demands for capable workers by defining what it means to be capable and qualified in this new area of practice. Teresa Adams, María Hart, and Kerri Phillips offer an example of another group—highway maintenance workers—that plays a crucial but widely under-appreciated role in transportation system operations and presents similar issues of worker recruitment, development, and retention.

To some extent, dealing with the issues of transportation workforces may require changes in the ways government transportation agencies do business. Practices that worked well when the primary business areas were system expansion and new construction may be less well suited to the demands of technology upgrading, maintenance, preservation, and redeployment of previous investments.

Newer generations of workers may find satisfaction in lifestyle choices representing values and priorities that differ from those of their predecessors. Operating in the public sector and, often, lacking the personnel-management resources and freedom that private companies enjoy, these agencies may be hard-pressed to compete for talent, both in younger workers and in experienced staff.
We hope this issue of TR News will illustrate both why the changes are important to everyone’s prosperity and wellbeing and how research and development of new tools for workforce management—human resources, organizational knowledge, and administrative practices—helps transportation agencies accomplish their future missions.

REFERENCES

NOTE: The TR News Editorial Board thanks Andy Lemer and Camille Crichton-Sumners for their work assembling and developing this issue.

Government and Private Sector: Now Hiring

Entry-, mid-, and senior-level staff needed for varied assignments in transportation system development and management at many qualification levels. Applicants must be

- Adept at dealing with technical matters, public engagement, and uncertainty;
- Able to maintain long-term perspectives while dealing effectively with emergencies and peak-load demands;
- Conversant with emerging, current, and obsolete technologies;
- Entrepreneurial, flexible, and patient with bureaucratic and political management processes; and
- Tolerant of recurring political pressure to do more with less.

Positions are based in central and field offices and remote locations, and may be subject to hiring freezes, reductions in force, and market fluctuations. Competitive salaries and benefits in some areas of specialization.
TBR has organized many resources and key stakeholders over the past decade to address a topic that has looming consequences for every mode in the transportation sector: insufficient workforce capacity. For example, a search of reputable transportation research databases pulled up more than 130 citations related to transportation workforce challenges. Although workforce development has received increased recognition, the industry at large still is not well positioned to handle current and growing workforce gaps. Current workforce gaps are further threatened by an underdeveloped talent pipeline, misaligned training and education priorities, and labor-market projections that suggest heightened competition with other sectors for similar skill sets (1–3).

Challenges

One fundamental reason for the transportation workforce gaps and related deficiencies is an antiquated, ad hoc thinking in addressing critical workforce needs. This thinking is not due to apathy or lack of desire to address complex issues but instead to the fast-paced nature at which new demands and technologies are introduced and to unwieldy bureaucratic rules and regulations, depriving the transportation sector of sufficient time or resources for adequate planning.

For example, transportation organizations often do not consider a recruitment strategy until a position is vacant and then must comply with civil service hiring requirements, or fail to compute the right staffing mix to meet new operational demands until service responsiveness and safety have been publicly questioned (1).

TALENT PIPELINES

Bymer, Chadwick, Hill, and Molloy point out that many organizations fail to establish robust and differentiated talent pipelines (4). This is a concern for transportation organizations, which often maintain narrow talent pipelines that may connect to a single, heavily drained source for talent, limiting the available pool of
applicants. For example, transportation agencies that source talent almost exclusively from local technical or vocational programs may quickly recognize that this talent source is also tapped by private-sector organizations that offer better wages, or perhaps that enrollment in those programs is too limited to provide the needed breadth of human capital.

Further, even the agencies that recognize the need to cultivate a robust talent pipeline often remain too focused either on building internal pipelines (that is, priming junior staff for succession when advancement opportunities are too far off) or on singular external pipelines and lack the resources to invest in both. In fact, transportation agencies that rely solely on strong internal pipelines may experience increased leakage as highly trained and motivated workers leave for better-paying jobs, particularly in competitive labor markets.

Likewise, agencies that dedicate nearly all their attention to external pipeline development may still miss the root of the challenge, which lies much earlier in the workforce chain—early education, where future workers often are first exposed to trades and industry jobs.

Additional recruiting and developmental problems emerge from agency budget constraints. Experience shows that investing in technical, leadership, and cross-functional training—all vital to building workforce capacity for transportation—tends to be an early casualty of increased competition for limited fiscal resources. This impact is particularly concerning for agencies that too often lose workers with vital leadership and specialized skills—technology, engineering, or trades, for example—to the private sector, leaving the agency with lower-skill workers who cannot accommodate the training needed to perform at the levels required for development.

Inadequate training also means that transportation agencies may be ill-equipped to prepare new workers for increasingly complex job requirements, leading to higher turnover rates, and that agencies end up with a smaller talent pool to draw from, further increasing competition for skilled labor with previous transportation experience.

**LACK OF INCLUSIVITY**

Other findings suggest the transportation industry and its male-dominated culture may be pushing aside the very talent needed to evolve and meet operational and technological demands. For example, research suggests women may not feel welcomed or attracted to the transportation industry (5–6). A 2015 Center for Transportation Research and Education project noted that, although women are an asset to transportation operation roles, fewer than 2% of the U.S. railroad workforce was comprised of females and fewer than 5% of drivers in the motor carrier industry were women (7).

The industry can find itself mired in old patterns and cultural norms that can result in a lack of inclusivity, making it unable to attract uniquely talented workers from a diverse population that includes women.

1 See https://ctre.iastate.edu/research/in-progress/women-as-assets-in-railroad-transportation-operational-roles/.

Goldie Seymour began her career as a company driver and now owns and operates her own truck. Women comprise less than 5% of the motor carrier industry.
and minorities. Historically, the transportation industry has not always been effective in welcoming and promoting sensitivity to generational differences—yet another important consideration for agencies seeking employees with specialized technical background and skills. Under this scenario, negative, unsubstantiated prejudices toward older workers may remain, as well as myths about older workers being resistant to new technologies or younger workers being less productive or committed to their jobs.

Without enhanced strategic and intentional efforts to welcome diversity, the industry will miss, and even lose ground with, a key segment of the labor market. In short, transportation organizations set themselves up for significant operational challenges if they remain in a bubble that prevents forward thinking and capacity building.

Cross-Modal Perspective

The need for increased strategic thinking on and planning for workforce requirements is not unique to any one transportation mode. One study revealed how transit leaders tend to function in a knowledge vacuum, fearing they will become dispensable if critical knowledge were shared across their workforce; this results in significant institutional knowledge deficits when workers retire or leave (1, 8).

INVESTMENTS AND IMAGE

Some transportation modes, such as rail, ceased investing in workforce research or mode-specific education for a significant period. Freight traffic may have declined, but with the recent increase in freight ton-miles and in the number of commuter and intercity passenger rail trips, the rail industry now lacks workforce capacity to address these renewed service demands (9). Similarly, although many airports embrace a seemingly progressive approach to business (for example, the enterprise-based model), they still have not invested in partnerships with training and education providers at a level necessary to promote innovative skill development and real-world practice (2).

Although these conditions suggest that recruitment efforts should be stepped up, including evaluating the competitiveness of compensation packages, there is also a need to look at the image the industry portrays; to ask the question: “Is transportation an intriguing or appealing sector to work in?” The all-too-frequent answer is that the transportation industry must reconsider its public image. According to the Transit Cooperative Research Program project “Building a Sustainable Workforce in the Public Transportation Industry—A Systems Approach,” industry image management, or lack thereof, was identified as a predominant barrier to transit agencies being seen as “employers of choice.” (1)

EARLY EXPOSURE

Apathy to early-career investment is another antiquated and reactionary approach to workforce development found in the transportation industry. Industries like health care and defense often recruit with more ease; students often learn about jobs in these types of industries in their early school years, sometimes as early as kindergarten. This lack of early exposure to transportation jobs has consequences throughout the educational trajectory; in fact, researchers found that awareness and interest in transportation-related jobs, particularly in the highway and construction sectors, may be decreasing as fewer primary-school students enroll in the science, technology, engineering, and mathematics (STEM) programs in which transportation jobs are typically introduced (10).

Increasing early exposure to STEM programs could mitigate this trend, particularly if transportation is included in the educational program by design. As long as transportation agencies do not invest in workforce development, the sector will not present as sophisticated and interesting workplaces, thereby increasing difficulties in attracting and retaining a well-trained workforce. Recruitment can be particularly difficult when competing business sectors have ramped up their culture savvy with a broader view into the future.

Why Change Now?

A common argument for remaining stagnant in workforce development is that “we have made it work for this long, so no need to change now.” Many agencies and research organizations realize the flaw in this argument and have addressed challenges and prepared for future workforce needs. For those that have not, it is time to change.
WORK AND WORKERS ARE CHANGING

It might be helpful to consider the shifts in the transportation industry, the working population as a whole, and public expectations around how work should be structured. Baby boomers, the largest sector of the labor market, are approaching retirement (11). In the Airport Cooperative Research Program (ACRP) project “Identifying and Evaluating Airport Workforce Requirements,” researchers conducted an interview with a prominent, large airport and learned that their entire executive team was eligible to retire in the next 5 years (8). This is not unique to this airport or this transportation sector; in fact, across every workforce development study identified in the transportation research databases, the baby boomer retirement effect receives at least a brief mention.

Second, demographic characteristics have shifted such that the labor market is comprised of many females, minorities, and tech-savvy millennial workers (11). Cultural and generational clashes are a real concern when building a sustainable workforce. Studies looking at diversity in transportation organizations have noted how difficult it is to recruit and retain females and minorities because of widely held perceptions that these organizations lack sufficient role models with similar demographic characteristics and offer limited advancement opportunities to women and minorities (12).

Other research has called attention to the perception of age-related barriers in transportation employment. For example, younger workers indicate that they prefer flexibility and work–life balance, but the transportation industry is generally not seen to champion these types of programs or flexible work arrangements. There also is an impression that transportation occupations are low-tech, which leads to problems recruiting emerging, younger workers (13). Similarly, researchers in rail workforce development have found that inflexible schedules affect family priorities and deter younger workers (14). In fact, the attrition rates for rail workers in the first 2 to 5 years of employment are higher than in other sectors of the economy.

In addition to retirements and demographic shifts, many transportation jobs will require increasing levels of technological expertise. The transportation industry is adopting new technologies and working with larger data sets to make predictions that come with a greater need for technical expertise in using associated systems effectively and in making timely decisions.

ACRP researchers identified that many, if not most, airport jobs will require an increasing level of technical skills (2). A 2016 article in TR News suggests that many of the highly technical jobs in airports—aircraft maintenance, technicians, air traffic controllers, operations staff, and pilots—are becoming more and more difficult to recruit for because although workers with specialized skills are needed, the talent pool is shrinking (15). The article also indicates that by 2024, more than 200,000 personnel will be needed to fill these types of specialized airport jobs and that sponsored education is crucial to make this happen.

TECH AND TRADES

In National Cooperative Rail Research Program Report 2: Guide to Building and Retaining Workforce Capacity for the Railroad Industry, researchers acknowledged that it is imperative for rail and other transportation modes to brand themselves as technology-savvy (14). Researchers highlight the importance of leveraging existing technologies, such as social media, to attract tech-savvy workers. Bus operations increasingly are adopting new technologies, including the use of tablets to track bus route scheduling (8). The demand for new talent with strong technology-focused skills is not unique to transportation, which is why attention to this area is so important—competition is steep.

Another weak area in workforce development is trades vocations. In one paper, researchers suggest that jobs with specialized skill requirements from civil engineering to trades are competing for talent across industries, with fierce com-
petition (10). In fact, the ACRP project cited earlier indicated that electricians are one of the top mission-critical jobs in the airport industry—and are at the greatest risk for vacancy across the industry (2).

The challenge is that many trades jobs in transportation—for example, electricians, construction, facilities, mechanics, HVAC technicians, and plumbers—also are found in other industries, particularly in commercial sectors that can offer better compensation packages.

Experience indicates that fewer and fewer students are entering the trades upon graduation. In many cases, lack of awareness of these jobs is blamed for the talent shortage, as well as the emerging sentiment that fewer students are entering vocational programs or technical schools because of an unrealistic push for all students to attend 4-year universities. This type of push often can set students up for failure if they are more interested in technical, specialized training than in higher education. An increased awareness of the opportunities linked to vocational training could have a long-term, positive impact on employment in the transportation sector as well as on the economy in general.

The transportation sector (both public and private) also would benefit from cultivating strong relationships with high schools and community colleges, since many are beginning to focus on areas of specific interest to particular industry sectors. For example, some high schools offer career and technical education (CTE) in technical skill sets that have direct application in the transportation sector, like welding.

Some high schools collaborate with community colleges to offer dual-credit opportunities, and many community colleges that offer vocation-specific courses align themselves with research universities by cross-listing courses and sharing campus facilities. Brymer et al. refer to “market thickening pipelines” as connections that organizations form with primary and secondary education institutions to expand talent within a particular functional area or trade (4). The transportation sector also can build strong connections to education institutions by supporting federal programs and grants to fund curriculum development tailored to industry jobs.

**Where to Go from Here**

With so much good research available, the answer to the challenge of transportation workforce is to make strategy the cornerstone of workforce development. Individual transportation modes need to evaluate their own gaps and determine where they lack investment in building workforce capacity. Perhaps more importantly, however, the industry must embrace commitment to a cross-modal vision of workforce development.

Strategic planning would bring together different transportation modes to conduct industrywide SWOT, or strengths–weaknesses–opportunities–threats analysis; to invest in knowledge sharing; to evaluate value propositions of human-capital initiatives; to explore opportunities for cross-modal partnerships and academies; to identify opportunities for resource pooling; to develop roadmaps for industry workforce sustainability; and to create a larger, industrywide vision for how invest significantly in workforce capacity-building over the next decade (see sidebar, page 12).

**INTEGRATED PERSPECTIVE**

To develop this cross-industry vision, it is necessary to view the various facets of workforce development with an integrated perspective. This means the industry would move away from implementing one-off human capital initiatives and look instead at the meaningful intersections between those initiatives. For example, when considering how to restructure or improve recruitment efforts, transportation agencies should examine internal retention practices and should determine which ones the current workforce finds most beneficial, which then could be highlighted in recruitment efforts.

In developing a recruitment approach, it also is necessary to look at internal employee engagement levels, organizational culture, and human resource data (for example, hiring–acceptance ratios and turnover) to determine whether incoming
Although investment in new strategy and practice can be costly and requires some prioritization, its benefits are likely to outweigh the costs of inefficient hiring, high turnover rates, and the contagious effects of low employee-engagement levels.

CAPACITY BUILDING

As the transportation industry builds its talent pipeline to ensure a robust, sustainable workforce, it must work to change the trajectory of workforce capacity building. Brymer et al. recommends that organizations are best served when they establish a diverse portfolio of internal and external pipelines that extend both into talent pools that have been productive historically as well as into sources that have not been fully explored (4).

For transportation, this could mean encouraging knowledge sharing across agencies to facilitate future workforce development. Implementing this process may also mean that agencies establish symbiotic relationships with one another, allowing talent to be funneled among organizations when opportunities for advancement are limited at one agency. Deep external pipelines could also include direct lines to other sources, such as talent search firms, membership organizations and associations, and education institutions, including primary K–12 schools, to maintain a steady stream of talent with specialized skills.

Individual transportation organizations must seek to build inclusive cultures that celebrate differences and an infrastructure that presents as dynamic and interesting to the incoming generation of workers. Outreach to educational institutions and training programs is needed for early pipeline development, including expanded vocational training options. An external focus also entails outreach and targeted messaging to underrepresented demographic groups, such as women and minorities, to remove stigmas and misconceptions about transportation jobs.

Brymer et al. emphasize the value of creating pipelines with membership organizations to promote diverse recruitment and hiring (4). CTE programs are an example of a potential pipeline to women and minority talent. By embracing an integrated, cross-modal perspective on workforce development, the transportation industry can rise above other industries, build deeper and broader talent pipelines, and be a cherished industry that talented and diverse workers seek to join.

REFERENCES

Although nuances exist across modes, all transportation modes are at risk of serious workforce capacity shortages in the next few years. There is good news, however—rigorous research and action planning is being conducted in each mode to mitigate the impact of workforce gaps.

The Federal Highway Administration embarked on a national collaboration to develop five regional workforce centers. The National Network of Transportation Workforce Development collects and consolidates best practices based on region-specific job needs. The American Association for State Highway Transportation Officials also has collaborated with state departments of transportation (DOTs) to incorporate transportation construction education into the early educational track for students, through initiatives like the Transportation and Civil Engineering program.

Similarly, the Transit Cooperative Research Program (TCRP) has funded projects that catalogue the best publicly available training opportunities sharable across transit agencies and that present market research on effective knowledge management strategies and tools (1–3). Transit research such as TCRP Report 162: Building a Sustainable Workforce in the Public Transportation Industry—A Systems Approach provides resources and strategies to promote benchmarking of best practices in workforce development, providing examples of image-management techniques to improve the view of transit employment (4).

The rail industry offers other examples of promising workforce research. A large-scale Federal Railroad Administration review of workforce challenges and improvement recommendations was published in a 2016 document, “Railroad Industry Modal Profile: An Outline of the Railroad Industry Workforce Trends, Challenges, and Opportunities—Update.” In 2014 and 2015, the National Cooperative Rail Research Program (NCRRP) invested in a large workforce development initiative, published as NCRRP Report 2: A Guide to Building and Retaining Workforce Capacity for the Railroad Industry, to outline workforce development strategies at the executive and management levels as well as the general workforce level (5).

In a recent two-phased project for the airports industry (ACRP Research Report 186: Guidebook on Building Airport Workforce Capacity), researchers spoke with 50 industry stakeholders and identified 21 workforce capacity-building strategies for airports (3). This Airport Cooperative Research Program (ACRP) study provides practical action plans to guide airports in the implementation of these strategies.
seekers realize that airports themselves offer career opportunities aside from airlines and the vendors who work within the airport space. Airports function as a unique ecosystem; although the system itself is fascinating from a cross-occupational standpoint, it may create confusion as to what types of jobs are available within airports.

The maritime industry also suffers from limited public awareness of its careers. Workers seldom realize the variety of maritime jobs available on both land and sea, with functions that span from operating ships to engineering, conducting safety operations, managing environmental protections and energy systems, and engaging in international business relations.

Like rail, transit can be viewed as a dated mode of transportation. An improved effort to share how transit connects communities and offers an array of job opportunities would better support workforce recruitment efforts. The transportation industry has an image issue. Many transportation jobs are considered too prescribed, with minimal task variety or little meaningful work.

Image Management
The transportation industry has an image issue. Many transportation jobs are considered too prescribed, with minimal task variety or little meaningful work. For example, school-aged young people tend to see rail as a “career of the past,” thinking of the vintage trains described by their grandparents; the introduction of high-speed rail, however, brings a dynamic flair that deserves greater emphasis. Investment in rail passenger improvements and high-speed rail can appear controversial in the media and long-term employment for passenger rail suffers as a result.

The image challenges of rail are not unique to passenger rail. Few outside the industry know that freight rail offers a range of high-tech employment opportunities with solid wages and benefits. For example, freight rail uses sophisticated equipment to maintain rails and roadbeds, including advanced sensor technologies and robust data systems.

Similarly, airports may be one of the most underrecognized employers; few job seekers realize that airports themselves offer career opportunities aside from airlines and the vendors who work within the airport space. Airports function as a unique ecosystem; although the system itself is fascinating from a cross-occupational standpoint, it may create confusion as to what types of jobs are available within airports.

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Highways typically receive more publicity simply by the nature of their existence, but the specialized transportation construction and maintenance areas of DOTs are similarly plagued with image issues. Therefore, branding—or rebranding—is needed in all modes to establish a new image across transportation. Instead of being seen as a “blast from the past,” the industry needs to focus the public on how it is the “transport into the future.”

**Employee Engagement**

Employee engagement can be defined as the internal counterpart to image management. Instead of computing retirement-eligibility or projected turnover rates, the industry would be better served by allocating attention to assessing and enhancing employee engagement. As an attitudinal and emotional reaction to one’s work environment, employee engagement naturally translates into positive organizational outcomes like increased work commitment, productivity, and tenure. The process of measuring employee engagement should also be paired with a comprehensive needs assessment to identify where a transportation organization might be falling short in meeting employee needs and reinventing itself as an “employer of choice.”

Transportation agencies need to examine current practices, daily scheduling, workplace policies and programs, benefits structure, and infrastructure to help their current workforce feel valued, promote attraction of future talent, and connect to desired outcomes for continued capacity building. When conducting a true needs assessment and evaluating employee engagement levels, organizations frequently find their own employees feel disillusioned, disconnected from the organization’s goals, unsupported, and unvalued. Employee referrals are a highly effective means of recruitment, so low engagement easily can stifle efforts to develop the talent pipeline.

**Workforce Development**

Another essential area of focus is to prioritize workforce development initiatives based on which jobs are most critical to meeting future operational demands and the competencies needed to address those demands. Further, competency models must relate directly to relevant training and educational programs, with greater outreach to and collaboration with educational institutions.

Internal hiring and recruiting programs also must be updated. Without knowing the required competencies and relevant skill sets, training and education programs may not address the evolving needs of the industry. Further, transportation agencies may invest in recruitment, retention, and development practices that are misaligned with real workforce needs.

Some TRB projects have begun to address this need, such as an ACRP airportwide survey of more than 700 participants to identify the most mission-critical jobs and an ACRP project identifying gaps in airport education and providing recom-
By enhancing professional capacity through cross-modal experiential learning and rotational assignments, the transportation sector can increase the transferability of skills for workers.

Recommendations to improve curricula. Recent rail research also provided a comprehensive set of competency models across four broad categories for rail transportation jobs (5).

Emerging educational programs across transportation sectors engage university faculty in the career requirements and opportunities within modes. For example, the Railroad Engineering Education Symposium and Passenger Railroad Engineering Education Symposium educate engineering faculty about railroad engineering opportunities. In addition, many institutions are developing curricula built around specific trades, such as Johnson County Community College’s National Academy of Railroad Sciences.

One National Cooperative Highway Research Program project identified likely future industry scenarios and job requirements for transportation planning occupations and mapped those requirements to competencies (6). Another identified the core functions and their associated skill sets that comprise systems operations and management (SOM) jobs, mapping these core SOM functions to U.S. Department of Labor classification codes (7).

Looking Across Modes
Transportation also can benefit from identifying cross-modal occupations and analyzing jobs to define the specific requirements and competency needs—first, by investing in rigorous job analysis methodologies that will help establish a firm foundation for competency modeling. This foundation then could be used to build meaningful career paths and improve recruitment, hiring, performance management, and development processes for the workforce.

Next, the industry should place more emphasis on professional capacity building at all organizational ranks, in addition to individual technical skill development. Professional capacity refers to equipping personnel with a broader perspective of how their organization functions and how to perform in different job roles. By enhancing professional capacity through cross-modal experiential learning and rotational assignments, the transportation sector can increase the transferability of skills for workers. Thus, a cross-modal perspective also would allow modes to compare their competency needs and expand their purview of talent availability, helping identify opportunities and design procedures for reskilling labor from other modes when job needs shift across modes.

REFERENCES
Imagine the following two scenarios. Which is more likely to happen in your organization?

**SCENARIO 1**
Joe rushes into the shed just ahead of the morning tailgate meeting. He boots up his computer and hurries to find the morning reports. After waiting for the printouts, he heads to the visual management board, 15 minutes late. Sophie and Eddy are talking by the bench. “C’mon, shake a stick, guys,” Joe says. He notes that the hood of Truck 57 is up and the oil filter box is unopened on the floor.

Pete, late again, hustles across to the team. “Hey Joe, here is my notice and badge. I am done with this place. My cousin got me a job at the county,” he says. Joe fumes as Pete walks out the door.

He scribbles on the reports and wonders how all the work is going to get done with two men down since Bob’s retirement last week. Human resources takes forever to get him new guys.

The team waits for their orders. An hour later, the crew is headed out to a job after getting assignments from Joe, finding tools, and finishing the oil change on the truck.

**SCENARIO 2**
Joe walks into the shed before the morning tailgate meeting. He scans the reports that Eddy has completed. After finishing the oil change, Sophie crawls out from under the truck. Joe meets the crew by their visual management board. Pete hustles in and says, “Hey Joe, here is my cousin Jerry’s resume. He just moved to town and he already has his CDL. He would work really well with the team.”

“Thanks, Pete. I will add him to the waiting list and he can interview next time we have an opening,” Joe replies. “But that’s not going to happen until I get one of you promoted—so let’s get to today’s challenge. Eddy, you have the lead this morning.”

Eddy starts with the safety briefing, reminding everyone of the situation they are going into. Joe observes the team interaction, making mental notes for his coaching sessions with each member. When the team breaks 10 minutes later, they each have clear assignments. They grab the tools they need and are out the door in 5 minutes.
How might you, as a leader, move from Scenario 1 to Scenario 2?

Transportation agencies across the country are struggling to retain and hire staff. The tsunami of retiring baby boomers is affecting every industry. In April 2018, there were 6.7 million job openings in the United States and just 6.4 million available workers to fill them, according to the Bureau of Labor Statistics (1). The battle for talent is fierce. Technology advances and generational differences complicate the situation, converging to create a war for talent that departments of transportation (DOTs) cannot afford to lose.

Any organization’s success is dependent on the people who work inside the organization. The ability to hire new people and keep quality people is both an essential element and an indicator of an organization’s success. My research explored 1) what new workers are looking for in a workplace, 2) what is driving those expectations, and 3) the gap between expectations and reality. I then identified strategies to close that gap to improve attraction and retention. The use of these strategies could create a competitive advantage to win over the new workers.

What Do New Workers Want and Expect?

LinkedIn asked this question and published the results in a June 26, 2018, blog post: “The main takeaway? Culture reigns supreme. Consider this: 70% of professionals in the U.S. today would not work at a leading company if it meant they had to tolerate a bad workplace culture” (2).

Used by leaders across the globe, the word “culture” means many things to different people. Culture is the culmination of all the things that affect behavior in a given circumstance or environment.

What kind of culture does a new worker want? Interviews with seven interns who were just starting at DOTs shed light on how their experiences measured up to their expectations (see box, at right):

- Most were expected to adapt to the workplace. Three DOTs adapted to be more appealing to the intern by removing cubicle walls and creating collaboration space.
- In every case, the interns were taught how to work and behave in the DOT environment, as opposed to the organization expressing interest in learning from the interns.
- Work processes were rarely documented in a manner specific enough to meet the intern’s needs.
- Younger interns were surprised by the significant age difference between themselves and their coworkers. They often found themselves in meetings in which the person closest in age was 10 to 15 years older.

All of these factors inform whether these interns will choose to work in a DOT in the future.
As a volunteer with university and high school students—and as a mom—I have noticed an emerging trend of alternative educational delivery models. One day I watched my 16-year-old son at the kitchen counter working on a group project with other students, none of whom was in the room, while the instructor provided real-time feedback into the document they were all sharing online.

I wondered about the effect these new generations would have on the workplace as well as whether we would be prepared for them. Alternative environments and models in schools are changing the expectations of students entering the workplace. The changes include job shadowing in high school instead of waiting until college; online learning environments; project-based learning; collaborative learning; student-directed learning; and specialty, focus, or magnet schools.

FOCUS ON FLEXIBILITY

Students are learning that flexibility and adaptability to the individual takes precedence over the mass-produced. The variety of options available to students creates an expectation that similar options will be available in the workplace. It is not a far leap for those same students to expect a workplace that is not one-size-fits-all—one that is not, for example, a cubicle environment for all front-line workers.

An August 2018 blog post from the Center for Generational Kinetics references three workplace-related statistics about the upcoming Generation Z, or “iGens”:

1) Working from home and telecommuting is expected, not a perk.
2) Sixty percent of iGen workers want multiple check-ins from their managers during the week. Of those, 40% want interaction with their boss daily or several times each day.

What Drives Expectations of the New Workforce?

3) Ample, light-filled spaces and sit-stand desks are preferred (3).

Each of these findings correlates to feedback from today’s students. Additional expectations created by alternative learning environments include autonomy for problem solving, cooperative coworkers, meaningful work with big-picture connectedness, and social impact.

Newer generations generally expect to have choices and flexibility, in contrast to members of earlier generations, who learned how to fit into and get what was given, to wait their turn and be glad for it. Many members of younger generations do not share this attitude and organizations need to figure out how to accommodate these expectations.

New Worker’s Criteria for Positive Employer Culture

- Not one-size-fits-all
- Work from anywhere, anytime
- Autonomy to problem-solve
- Collaborative environment
- Cooperative coworkers
- Frequent, timely feedback
- Meaningful work
- Big-picture connectedness
- Social impact
- Contemporary
- Shared values

How many boxes can you check?
WHAT GENERATIONS SHARE
At the National Transportation Advanced Leadership Institute, Tom DeCoster teaches that all generations share seven values. All employees want to feel respected and listened to and want to understand the big picture. Additionally, all employees want to have opportunities for mentoring, effective communication, positive feedback, and an exchange of ideas. Foundationally, these values and experiences should be in place before an organization begins to add special accommodations for any specific generation.

Understanding 1) the change in worker expectations and 2) the gap between the expected and actual worker experience is critical to effectively responding to the risk. Using what I learned through interviews, observations, and research, I identified three key, tested strategies leaders can use to attract and retain employees.

Three Key Strategies to Attract and Retain Employees
Organizational-level efforts set the intent, tone, and vision, but actual employee experiences determine the culture—and, ultimately, outcomes. Balancing the two requires dedicated leadership focus (see Figure 1, at right). The following strategies focus on creating a culture to improve employee attraction and retention. Each strategy is exemplified by non-DOT- and DOT-specific best practices.

LEADERSHIP
Objectives 1) Align leaders on vision, mission, and values—set the tone; 2) set direction and clarify goals, roles, and track results; and 3) have concern for people, culture, strong empathy, and soft skills.

Rationale The best DOT practices I examined all happened because of strong leadership. In every case, a leader or team of leaders took a strong approach to creating visions, aligning leaders, and engaging with the workforce. These leadership practices create spaces for employees to thrive because they are valued and safe, which is accomplished through clearly communicated expectations in a unified tone at all levels in the organization. Team leaders then ensure employee experiences that create an engaged, improvement-oriented culture.

Practice Outside DOT Once employees feel safe, they are less threatened by impending change and are more likely to be facilitators and champions instead of roadblocks. In his book, Creativity, Inc., Ed Catmull describes his journey to becoming president of Disney Animation while also leading Pixar. The Disney workforce was intimidated and fearful of leadership, unlike the culture he had created at Pixar. That was the most fundamental change Catmull wished to create: how to get Disney employees to feel safe so they could engage candidly like Pixar employees.

DOT Best Practices When Brian Ness began as director of the Idaho Transportation Department (ITD), one of his strategies was to reduce organizational layers and position decision-making closer to where the work was done. This required engaging employees in a new way. To achieve this, ITD asked employees both what they want from an ideal workplace and how they feel in the current workplace. The feedback informs actions to move toward a more desirable culture as defined by employees.

WORKFORCE ENGAGEMENT
Objectives 1) Start right—hire for culture, use an onboarding process, and conduct new employee orientations; 2) develop technical and soft skills—train and mentor; and 3) create intentional experiences and solve problems in cross-functional teams.

Rationale Intern interviews revealed that one of the biggest indicators for seeking a post-college job with the DOT was based on what current employees told the interns in casual conversations—that is, workplace culture. Word of mouth is powerful. If an organization has a positive culture, it is more likely...
everything must be done with consideration for breath and space. If the concept of breath and space is applied to the workplace, simply becoming aware of where things are tight and tense can help to identify what can be done to adjust the space or the motion to give people back a sense of security or, sometimes, mastery. Giving people a sense of balance in their work will return dividends to the workplace.

Practices Outside DOT

Corporations like GE, Danaher, and Toyota make good use of Six Sigma and Lean process improvement tools, modeled after the Toyota Production System (4). These tools have the power to deliver incremental and breakthrough change and are the “secret sauce” to many profitable enterprises.

DOT Best Practices

Colorado DOT advances innovation internally via its Lean Everyday Ideas program. Additionally, Gary Vansuch, Director of Process Improvement at Colorado DOT, has successfully launched and sustained communities of practice among DOTs, such as the Lean Transportation Forum and the Change Managers Forum. These forums are prime incubators for networking, innovation inspiration, and the sharing of best practices among DOT representatives.

Innovate ITD! is a platform by which employees are empowered to share ideas and implement innovations. The notion that employees can identify and make improvements and share those best practices throughout ITD is one of our great successes in improving culture. The purpose of Innovate ITD! is to foster engagement among employees. Innovation is one of the top things employees ask us to keep doing in their feedback. We have been told repeatedly that our innovative culture is a key consideration for new employees in the onboarding process.

Blending the Strategies

To create an attractive environment, we must think about the people already in that environment. How can we engage staff in this process of improving without eroding workplace culture? A positive
culture is essential to attract and retain employees. How do we change without negatively displacing the current workforce? By blending strategies and engaging the workforce so that its members are the architects of the change instead of subjected to it.

If the current workforce does not see the future workforce as the enemy but focuses on attracting and developing it as an ally, it can create powerful momentum to attract future talent.

Traditional internships and onboarding processes are designed to adapt employees to the workplace. Borrowing concepts from human-centered design thinking, consider another approach to onboarding employees: if the new employee is considered a “customer” or “user,” we might design a solution more suited to their needs.2

Conclusion
In order to attract new talent, transportation agencies must have an engaged workforce. We need to engage with existing workers to create needed change; to impose change on the workforce is counterproductive. If we allow our staff the opportunity to work on organizational challenges with the intent of making DOTs a great place to work, we will be better positioned to attract future workers. Engaged employees with strong leadership and clear direction will create improved processes and environments, which then attract like-minded workers who share a desire for high-achieving environments. Properly sustained, this model can become a self-fulfilling formula for success in winning the war for talent.

References
3. Center for Generational Kinetics. 3 Things Employers Need To Know About Gen Z. http://genhq.com/3-things-employers-need-to-know-about-gen-z/.

Recommended Reading

Transportation agencies and contractors have often struggled in their efforts to achieve goals for gender and ethnic diversity reflecting society’s recognition of shared aspirations and expectations. Despite progress, statistics continue to show how much more there is to do, and demographic projections suggest the situation will not be resolved by inaction. More importantly, however, recent studies show that organizations with the most diverse workforces realize better decision-making and more efficiency, innovation, and profitability than do their less-diverse peers.

Demographic trends shaping the nation’s workforce—the large millennial population, the rise of neurodiverse workers, and dramatically increased ethnic diversity—mean that increasing diversity in the transportation business not only is essential to agency mission achievement but also can be a force for improved performance. With the ever-changing impacts of technology, it is crucial to attract a highly skilled and diverse workforce to ensure the nation remains at the forefront of innovation.

Why Focus on Diversity?
Nationally and globally changing demographics mean that organizations that want to remain competitive and innovative must create a culture that is supportive of diversity (1–2). A diverse workforce is a critical way to supply the variety of perspectives and skillsets needed to successfully solve complex, future global challenges (3). By definition, diversity encompasses not only traditionally recognized measures—gender, race, and ethnicity—but also age, socioeconomic status, veteran status, orientation, neurodiversity, experiences, and a host of other characteristics.

For the first time in the nation’s history, five generations soon will be engaged simultaneously in workplaces. As the number of baby boomers in the workforce begins to decline, millennials now make up the largest portion of the adult pop-
ulation, with the number of members of Generation Z rapidly growing (4).

Women’s representation in the workforce (47%) is nearly equal to that of men (53%); the number of women in the workforce has grown by 12% since 2000 (5). Racial and ethnic diversity also is increasing; projections indicate that by 2055, for the first time in U.S. history, no single ethnicity will hold a majority (6).

Neurodiversity also has received more attention, particularly given recent estimates that 1 in 59 children in the United States have autism (7). Based on these statistics, it is imperative to attract diversity into the transportation industry simply to ensure that enough workers required to design, operate, and maintain transportation systems are engaged in the workforce.

**IMPROVED ORGANIZATIONAL PERFORMANCE**

A much more important reason for agencies to achieve diversity and inclusion, however, is increased organizational performance. Studies show that organizations with the most diverse workforces see significant increases in efficiency, innovation, and profitability along with improved decision-making (1, 8). Research from McKinsey & Company shows that ethnically diverse and gender-diverse organizations are 35% and 15% more likely, respectively, to achieve above-average financial returns (9).

The impact of diversity is significant at both extremes. Thus, a critical mass of diverse perspectives—not simply tokenism—is required for an organization to derive benefits (10). These benefits also are not exclusive to a particular type of diversity. A 2016 Boston Consulting Group study found a statistically significant positive relationship between innovation—defined as increased revenues from innovative products and services—and the diversity of companies’ management teams, in terms of members’ industry backgrounds, countries of origin, career paths, and genders (11). Specifically, companies with higher-than-average levels of diversity composition in management teams generated 19% more innovation revenue than those with average or low levels of diversity.

**DIVERSITY IN LEADERSHIP**

The study also found that for diversity to make a difference in innovation performance, at least 20% of an organization’s leadership must be female; even with broad gender diversity among all employees, benefits are not fully realized without females in leadership roles. These findings are important for transportation agencies in which performance measurement have become a standard business practice; increased innovation and efficiency is essential in the age of automated and connected vehicles, Vision Zero, the Internet of Things, and big data.

**NEURODIVERSITY**

Recent recognition of the added dimension of neurodiversity leads to further examination of its impacts within an organization (12). Neurodiversity arises from the inclusion of individuals with atypical neurological expression in the workplace, which is important given that an estimated 2% of the U.S. population is neurodiverse (7). Autism, attention deficit–hyperactivity disorder, dyslexia, dyspraxia, and a range of other conditions lead to differences in the ways individuals think, learn, and communicate.

Although on the surface these differences may seem to create barriers to efficient workplace operations, they can be very beneficial. Neurodiverse individuals not only may have areas of very high ability—particularly in mathematics, computer applications, and other areas in high demand with transformative technologies—but, because they approach a problem differently, may develop more innovative solutions and recognize patterns and root causes more readily (13). Neurodiverse workers also tend to be more loyal than other workers are and are highly productive when job tasks are matched to their skillsets (14).

**RECRUITMENT AND RETENTION**

Not only does diversity lead to better performance and bottom lines, but it also is important to recruitment and retention. More than 65% of job seekers indicate that workplace diversity is a critical factor in their decision-making process around accepting a job (8). A study conducted by the U.S. Department of Commerce...
The lack of diversity in these occupations is magnified the higher up the ladder one travels. It is not only STEM and other traditionally male-dominated fields in which diversity is a challenge at higher levels: across all occupations and industries, women are significantly underrepresented in leadership positions. This trend holds true for ethnic diversity as well. African American and Hispanic workers are disproportionately represented in lower-wage occupations and men of color make up even less of the managerial workforce than do women (18).

### Additional Challenges for DOTs

State departments of transportation (DOTs) face even greater challenges, with a general lack of awareness of job opportunities and many misperceptions about transportation careers at these agencies (19). Additionally, the positive impact of transportation professionals on communities goes largely unnoticed, particularly for those in public-sector roles (20–27).

These challenges pose a particular problem in recruiting from traditionally underrepresented groups, as one of the transportation occupations (18). African American and Hispanic workers are even less represented than women are in many key transportation-related jobs, particularly those in science, technology, engineering, and mathematics (STEM) fields. Women and minorities also are significantly underrepresented in engineering and computer occupations, both of which are extremely important to the increasingly complex, technology-enabled, and data-driven workplace.

### Diversity Challenges

Within the transportation workforce, representation of women and minorities varies by mode and occupation (see Table 1, at right). Although women’s representation in the workforce has grown dramatically over the past 50 years, women still make up a small fraction of workers in

<table>
<thead>
<tr>
<th>OCCUPATION</th>
<th>TOTAL JOBS</th>
<th>PROJECTED GROWTH 2016–2026 (%)</th>
<th>WOMEN (%)</th>
<th>BLACK OR AFRICAN AMERICAN (%)</th>
<th>HISPANIC OR LATINO (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil engineers</td>
<td>461,000</td>
<td>11</td>
<td>14.4</td>
<td>6.4</td>
<td>10.7</td>
</tr>
<tr>
<td>Construction and building inspectors</td>
<td>89,000</td>
<td>10</td>
<td>10.2</td>
<td>9.8</td>
<td>11.2</td>
</tr>
<tr>
<td>Construction managers</td>
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<td>11</td>
<td>7.4</td>
<td>4.9</td>
<td>12.4</td>
</tr>
<tr>
<td>Computer systems analysts</td>
<td>554,000</td>
<td>9</td>
<td>38.9</td>
<td>9.7</td>
<td>7.2</td>
</tr>
<tr>
<td>Electrical and electronics engineers</td>
<td>284,000</td>
<td>7</td>
<td>12.3</td>
<td>3.5</td>
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<tr>
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<td>8.3</td>
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<td>Engineering technicians</td>
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<td>28</td>
<td>20.2</td>
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Achieving Diversity and Inclusion

Achieving diversity goals requires examination of both recruitment and retention practices. It is not enough to hire diverse workers; strategies must also be deployed to create an environment of inclusivity for a culture of diversity to develop. At the outset, an organization must define the value system and motivation for addressing diversity and inclusion.

STRATEGIC APPROACH

It is not enough to place emphasis on increasing diversity—to be successful, organizations must articulate the value behind this decision clearly (16, 20). This requires that leadership understands the role of diversity in the organizational structure and in the strategic plan (1). One approach to ensuring clear leadership is through including diversity and inclusion specialists as part of the human resources team or in a diversity and inclusion division. Organizations such as Indiana DOT and Missouri DOT have moved to these models.

ENGAGEMENT

Engagement is the key to addressing recruitment and retention of diverse workers. For transportation agencies to be successful in attracting and retaining diverse workers, they must first examine current practices through a lens that considers the individuals they are trying to recruit, by working closely with diverse groups of current employees to examine current practice and develop more innovative approaches designed specifically for a more diverse audience (15, 20).

For example, Minnesota DOT includes employee resource groups focused not only on providing support for the employees themselves, but also on helping the department achieve its mission in employee development, recruitment, retention, and outreach. Minnesota DOT also has established diversity and inclusion committees within all its divisions.

For organizations with limited diversity, working with community organizations that serve populations of interest can help provide needed insight and may lead to partnerships that strengthen the pipeline of diverse applicants. This can include direct partnerships with K–12 and postsecondary institutions.

Pennsylvania DOT offers an example of this type of partnership through targeted and structured outreach to high schools with diverse populations. The agency developed the School to Employment Program (STEP), providing academic-year internships to high school seniors. STEP has been successful not only in exposing students to career opportunities, but also
in attracting them to Pennsylvania DOT either through immediate employment or through a college internship program.

**COLLABORATIVE INITIATIVES**

Partnerships and collaboration across the industry are critical given the scale of the workforce issues in transportation. This is demonstrated by the number of organizations prioritizing workforce development initiatives that focus on collaborative approaches. The Federal Highway Administration (FHWA) operates the Center for Transportation Workforce Development out of the Office of Innovative Program Delivery, focusing on children ages K–12 through adults of working age, through a series of programs that engage a variety of stakeholders.

In 2014, FHWA also established the National Network for the Transportation Workforce (NNTW) via five regional centers of excellence charged with developing 100 strategic workforce partnerships engaging public- and private-sector stakeholders, disseminating best practices, and coordinating initiatives across regional and national footprints.

One of the five regional centers, the Southeast Transportation Workforce Center, hosts an annual Choosing Transportation Workforce Summit developed out of the NNTW activity, bringing together stakeholders to discuss and share best practices, key challenges, and strategies that can improve workforce outcomes. The summit also facilitates engagement among transportation professionals and high school and college students to increase awareness of and interest in transportation careers. Outcomes from the summit have included many students choosing to pursue transportation-related majors and career paths; several grassroots pilots addressing specific workforce challenges, such as increasing the number of women in the industry; and a new transportation- and STEM-focused high school (25).

The transportation systems management and operations (TSMO) subdiscipline provides another example of productive partnerships leading to workforce best practice. The National Operations Center of Excellence (NOCoE) is a partnership of the American Association of State Highway and Transportation Officials, the Institute of Transportation Engineers, and the Intelligent Transportation Society of America, with support from FHWA. The purpose of NOCoE is to develop innovative workforce strategies collaboratively and to provide a one-stop shop for resources supporting TSMO professionals.

**OTHER STRATEGIES**

Other specific engagement-focused strategies to attract diverse workers to the transportation industry include experiential learning such as internships and apprenticeships. These programs can be particularly effective for underrepresented groups, members of whom may have little prior knowledge of these fields and may lack confidence that traditionally white, male-dominated roles are a good fit for them. U.S. DOT is among several federal agencies that boasts a rich history of promoting apprenticeships. Codified as law and policy and related to transportation funding, opportunities for individuals to gain workplace skills are well established throughout the agency’s operating administrations, such as FHWA or the Federal Motor Carrier Safety Administration.

In addition to recruiting a diverse workforce, employers must develop programs to retain employees and must fully recognize that being competitive in a global economy requires full utilization of the skills and talents of all employees. Pennsylvania, Minnesota, and Missouri DOTs all have found mentoring programs to be effective for improving employee retention.

When considering neurodiverse individuals, strategies for retention include creating supportive environments, such as offering quiet spaces, allowing noise-canceling headsets, using soft lighting, and more; providing very specific and intentional training on workplace practices; and providing well-trained mentors and team buddies (1, 13).

Additional ideas to consider when creating an inclusive culture and retaining workers include paying a fair market wage,
considering the location of physical office buildings, creating flexible work arrangements to address work-life balance, and making sure the pay scale is equitable. A recruitment and retention study by Washington State DOT revealed that its compensation for engineering and technical workers is significantly under market (26). This disparity needs to be addressed because the agency is projected to lose nearly 45% of its current engineering workforce in the next 5 years. The percentage of employees at Washington State DOT are satisfied with their work; however, people continue to leave for better pay. The percentage of employees who leave the agency for better pay elsewhere is approximately 15% (26).

**Conclusion**

At any organization, employees are both its largest investment and its greatest asset, and thus must be protected. Workforce solutions of the future must be much more tailored than in the past, given national demographic trends. Practices must consider a wide spectrum of diversity and cannot be one-size-fits-all. Approaches to recruitment and retention should emphasize the individual in order to achieve the greatest level of success, both in attracting and retaining employees and in helping them achieve their full personal and professional potential.

Many strategies that are successful for recruiting and retaining underrepresented groups also are effective for all workers, so agencies can expect to see improvement in workforce outcomes across the board by designing diversity and inclusion practices to target varied populations. Although there are many examples of successful practices for achieving diversity and inclusion goals, more targeted research and case studies are needed to provide in-depth understanding and specific organizational guidance, especially in the case of neurodiversity.

**REFERENCES**


Departments of transportation (DOTs) and other transportation agencies across the country face ongoing and evolving challenges in providing transportation solutions to meet an increasingly complex set of external forces. Agencies will need to prepare their organizations for a new future characterized by the following:

- Continued development of connected and automated vehicles, shared mobility services, and electric vehicles;
- Adoption of new information technologies affecting nearly every aspect of transportation agency management—from planning to engineering design and construction to maintenance and operations;
- Changing political landscapes with funding instability, shorter legislative tenures because of term limits, and high expectations for accountability and transparency;
- Increased emphasis on transportation system management and operations to make better use of available capacity;
- Growing recognition of the need to improve resilience through strategies to manage risk and recover from transportation system disruptions caused by extreme weather and other emergency situations; and
- Challenges recruiting and retaining employees caused by competition with the private sector, changing expectations of flexibility and upward mobility, legislative limitations of public agency staff, erosion of public-sector benefits, and changes in the public perception of civil-service careers.

In October 2016, the National Cooperative Highway Research Program (NCHRP) initiated Project 20-24(95), “Ensuring Essential Capability for the Future Transportation Agency,” to help DOTs anticipate and adapt to this new future. Project objectives include identifying and describing emerging issues and trends, engaging senior agency leadership and others in discussion of the leadership challenges created by these issues and trends, and providing guidance on strategies to understand and meet these challenges.
Framework for Anticipating and Responding to Change

The initial phase of this research is complete and produced a framework to help agencies navigate the common set of challenges they face and identify appropriate solutions. The framework was developed from a literature review, interviews with DOT staff (executives, senior staff, human resources representatives, and employees under age 40), and four workshops held in conjunction with the American Association of State Highway and Transportation Officials in 2017.

The framework has three major components: change forces, needs, and strategies.

CHANGE FORCES
Change forces—external technological, social, and institutional factors that can fundamentally alter the focus of what DOTs do, how they operate, and how they interact with customers and stakeholders—create the need for agency adaptation.

Change forces create new opportunities for innovation. For example, advances in GPS technology have had far-reaching impacts on data collection, road construction techniques, and developments in the connected and automated vehicles arena. Other change forces, such as funding instability, constrain how DOTs accomplish their work.

NEEDS
Needs describe what DOTs must do to adapt to the change forces. Adaptation involves aligning workforces to match changing requirements as well as deliberate steps to accelerate technology adoption, increase organizational agility, and shift to more customer-focused and transparent ways of working.

STRATEGIES
Strategies are techniques that can be implemented to strengthen agency capabilities in meeting future needs. They fall into five broad categories: organizational management strategies, including performance management, change management, and process reengineering; workforce management, including succession planning, recruiting, and training; knowledge management, including mentoring, learning communities, and knowledge-base development; information and data management, including governance and strategic planning; and internal and external collaboration (see Figure 1, page 30).

Validating the Framework
Transportation agency staff at regional workshops provided several examples of challenges and strategies that were used to validate and enhance an initial version of the framework.

Although all agencies face the same set of change forces, they are affected differently depending on local economic and political conditions. Examples of challenges from workshop participants related to the change forces and associated needs were:

An Oregon DOT engineer demonstrates drone use. New skills and processes will assist agencies in adapting to and integrating new technologies.

Changes in GPS and other technologies that are commonly used by transportation agencies have strong implications for other innovation opportunities.
LEGISLATION, REGULATION, AND FUNDING

Agility and Resilience  
Budget cuts and downsizing have led to the loss of experienced staff, creating gaps between the work that needs to get done and the capacity of the organization to do it. Continued funding instability creates a reluctance to fill positions that become open because of attrition. It is becoming necessary to operate with a smaller staff footprint.

Workforce Evolution

Attracting and Retaining  
It is difficult to find people qualified to fill open positions. Engineering positions, jobs requiring technical expertise in information technology and data analytics, and specialized planning and financial staff positions are particularly challenging to fill.

PUBLIC EXPECTATIONS

Aligning Skills to Needs  
The involvement of advocacy groups increases and elevates consideration of multimodal options, sustainability, equality and equity, and public health. Responding to these concerns requires training as well as new tools and techniques to introduce new ways of thinking, broaden traditional approaches to transportation problem solving, and

Younger workers tend to operate under different motivations: the desire for purpose-driven work, quick upward mobility, and a comfortable work environment. Recruiting and retention strategies need to be retooled accordingly.
improve the ability of staff to collaborate across traditional organizational silos.

**Transparency** Increasingly, agencies need to explain clearly what they do, what is being accomplished, the impacts of cutting funding, and the basis for decisions about how resources are allocated. This requires improvements to data and information management practices and communication skills.

Workshop participants talked about a wide range of strategies for tackling these challenges through partnerships and in various management sectors (organizational, workforce, knowledge, and information and data).

**Next Steps**

In the second phase of NCHRP Project 20-24(95), guidance is being developed that will help DOTs navigate the many challenges they face and identify appropriate solutions.

The guidance will be available in print and online to provide a dynamic, updatable resource. The print guide will present the framework and practical examples that DOTs can refer to in developing their own tailored approach to change. See Table 1 (at right) for a list of relevant TRB research that has been conducted over the past decade.

The guide’s online component will allow continuous addition of agency examples, to keep the guidance freshly relevant and to facilitate sharing. The online guidance will serve as a one-stop shop for resources related to the building of organizational capabilities. It will leverage a growing body of research and experience on topics related to DOT capabilities and workforce strategies.

| TABLE 1 Recent and Active Cooperative Research Programs Projects on Workforce Issues |
|-------------------------------|-------------------------------|---------------|
| **PROJECT**                   | **REFERENCE**                 | **STATUS**    |
| NCHRP Project 02-25           | Workforce 2030: Attracting, Retaining, and Developing the Transportation Workforce—Design, Construction, and Maintenance | Active        |
| NCHRP 08-125                  | Attracting, Retaining, and Developing the Transportation Workforce: Transportation Planners | Active        |
| NCHRP 20-07/Task 408          | Transportation System Management and Operations (TSMO) Workforce: Skills, Positions, Recruitment, Retention, and Career Development | Active        |
| NCHRP Project 20-05/Topic 49-10 | Transportation Workforce Planning and Development Strategies | Active        |
| NCHRP Project 20-24 (100)     | State DOT CEO Leadership Forum: A Focus on Transportation | Complete (2014) |
| NCHRP Project 20-72           | NCHRP Report 636: Tools to Aid State DOTs in Responding to Workforce Challenges | Complete (2009) |
| NCHRP Project 20-80 Task 2    | Long-Range Strategic Issues Facing the Transportation Industry | Complete (2008) |

**NOTE:** NCHRP = National Cooperative Highway Research Program; TCRP = Transit Cooperative Research Program.
Government transportation agencies continue to evolve from infrastructure builders to balanced operations organizations that increasingly focus on transportation systems management and operations (TSMO). The need has arisen not only to attract, retain, and evolve traditional positions such as traffic engineers but also to recruit a more technologically diverse workforce. A more diverse workforce needs to have expertise in supporting emerging technologies such as connected and automated vehicles, big-data analytics, and sophisticated decision support systems. The TSMO activities of departments of transportation (DOTs) and other government agencies likely will need to change dramatically over the next 10 years because of the increasing speed of technology’s impacts on transportation.

Under the auspices of the National Operations Center of Excellence and funded by the National Cooperative Highway Research Program (NCHRP), several resources have been developed—skills requirements, position descriptions, and career pathways—to help government transportation agencies understand and address the challenges of securing and maintaining their TSMO capabilities.

In addition to providing organizations with usable materials for revamping their TSMO hiring and knowledge development, the project offers lessons to meet other workforce needs associated with new technologies. The following sections outline key project activities and outcomes for NCHRP Project 20-07(408).

Highest-Priority Issues

To determine key challenges faced by transportation agencies, researchers conducted a series of interviews with the staff of more than 30 DOTs, along with a comprehensive literature review related to TSMO workforce development. The highest-ranked issues were 1) the lack of existing training versus emerging needs and 2) the lack of a clear career path development for TSMO.
to develop a set of forward-looking roles and responsibilities for TSMO positions. Table 1 (page 34) provides suggestions for future incremental evolution in several traditional positions.

### Recruiting New and Emerging Positions

As part of NCHRP Project 20-07(408), interviews with many DOTs and two virtual workshops helped identify 19 new and emerging positions. Researchers then developed initial motivations, or triggers; position descriptions, including how each can improve CMM maturity (see Figure 1, page 35); and associated knowledge, skills, and abilities (KSAs) for each position. A brief description of the positions considered under this project and the rationale for including each position follows.

- **Traffic Data Scientist/Statistician.** An added emphasis on data science is required as very large amounts of data become more important.

- **TSMO Manager/Chief/Bureau Director.** As TSMO is elevated in government agencies, the roles and responsibilities of higher-level executive management are necessary.

- **TSMO Program Manager.** Several early adopters of TSMO have created program manager positions to coordinate across the wide array of functional areas and to implement activities that call for a broad range of internal and external stakeholders.

### Transitioning Existing Positions

Government transportation agencies, and especially DOTs, historically have been organized to expand and deliver infrastructure capacity. As society begins to place more value on system performance and reliability, however, the use of technology to manage infrastructure more effectively and share information quickly has become more appealing.

Over the past decade, transportation agencies have advanced different approaches to organizing and creating a program structure for TSMO in order to manage and operate the transportation system effectively. For example, reliability-related research under the second Strategic Highway Research Program played a pivotal role in the concept of TSMO program planning by examining both the technical and organizational support needed to enhance highway operations and travel time reliability at state DOTs and metropolitan planning organizations.

NCHRP Project 20-07(408) research developed a capability maturity model (CMM) consisting of six key dimensions to help transportation agencies improve the effectiveness of their TSMO activities, which specifically included organization and workforce in terms of organizational structure, staff development, and recruitment and retention. This and other efforts have enabled DOTs to slowly adopt and transition more positions related to management and operations of the transportation system.

Before thinking about new TSMO positions, over the next 5 years it is critical to evolve technical capabilities of the existing workforce. NCHRP Project 20-07(408) built upon the framework established from previous efforts, as well as a literature review from relevant fields, to develop a set of forward-looking roles and responsibilities for TSMO positions. Table 1 (page 34) provides suggestions for future incremental evolution in several traditional positions.

### Other key findings include:

- Most agencies continue to operate with staffing restrictions.
- Although about one-half of new hires are civil engineers, trends suggest a growing recognition by DOTs of the need for other professions to deliver high-quality TSMO services.
- Most states appear to have some difficulty filling key technical positions, especially in systems engineering, information technology, and intelligent transportation systems (ITS) device maintenance; approximately one-half of the states depended significantly on consultants.
- Existing TSMO staff members tend to be experts in one or more subject areas; not many have broad, diverse expertise.
- Very few people coming into the TSMO profession are properly prepared to meet existing needs.
- Recruitment difficulties are related to salary competition, lack of required skills and certifications, or both.

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Connected and Automated Vehicle (CAV) Program Manager. Many government agencies have hired program managers to work on issues related to developing the capacity to support CAV technologies through research, testing, and partnerships with industry.

Traffic Incident Management Program Manager. Working with partners to improve responses to traffic incidents is crucial to driving down clearance times and secondary

Data Management Specialist. As a complement to computer engineers and data scientists, data management specialists are responsible for curating data in a way that ensures a high level of reliability and accuracy.

Visualization Specialist. Along with analysis performed by data scientists, visualization of large amounts of data in an easy-to-understand way becomes important. The information

Computer Engineer. Specialized computer engineering is required as processing becomes more distributed and as more and more operational decisions are made through edge computing in the field as opposed to a centralized model.

Artificial Intelligence (AI) Scientist. Government agencies currently have very little experience with AI, but this will rapidly change as cooperative automated transportation becomes more broadly deployed.

Telecommunications Engineer. As private and public communication networks become ubiquitous and more bandwidth is required for emerging technologies, staff who can design the best ways to communicate with fixed and mobile assets will become more critical.


table 1 evolution of existing positions

<table>
<thead>
<tr>
<th>JOB TITLE</th>
<th>FUTURE ROLES AND RESPONSIBILITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Engineer</td>
<td>• Use spatial data, such as GIS and relevant spatial analyses and statistics, for data-driven decision-making. • Advocate for the appropriate TSMO countermeasures during the planning, design, and construction of highway projects as appropriate. • Consider CAV impacts on traffic operations.</td>
</tr>
<tr>
<td>Traffic Signal Engineer</td>
<td>• Incorporate ICM techniques into the operations of traffic signals. • Consider CAV impacts on traffic signal operations. • Effectively use GIS and other analytical tools such as SPSS/STATA and traffic simulation and signal timing software (e.g., VISSIM, CORSIM, and Synchro) to create information that enhances operational decision-making.</td>
</tr>
<tr>
<td>Freeway Operations Engineer</td>
<td>• Incorporate ICM and other demand-management techniques into the operations of freeway facilities. • Consider CAV impacts on freeway operations. Consider and manage new techniques such as automated vehicle–only lanes. • Take a multimodal approach to freeway operations. • Use real-time data to make real-time operational decisions. Implement and use prediction software to make operational decisions.</td>
</tr>
<tr>
<td>Arterial Operations Engineer</td>
<td>• Incorporate ICM techniques into the operations of arterial facilities. • Consider CAV impacts on arterial operations. • Take a multimodal approach to arterial operations. • Use real-time data to make real-time operational decisions. Implement and use prediction software to make operational decisions. • Identify, analyze, and interpret trends or patterns in complex data sets.</td>
</tr>
<tr>
<td>ITS Design Engineer</td>
<td>• Integrate connected vehicles into ITS design. For example, add DRSC or 5G connectivity as needed. • Use modern technology in ITS design including CIM.</td>
</tr>
<tr>
<td>ITS Planner</td>
<td>• Use big data to analyze benefits of TSMO strategies and implement if feasible. • Mainstream TSMO into the project-planning process. • Implement modeling for analysis, visualization, planning, and training related to TSMO programs. • Perform scenario planning to plan for CAV.</td>
</tr>
<tr>
<td>Transportation Planner</td>
<td>• Mainstream TSMO into the project planning process. • Integrate management and operations strategies into the metropolitan transportation planning process to maximize the performance of the existing and planned transportation system. • Implement modeling for analysis, visualization, planning, and training related to TSMO programs. • Take a multimodal approach to transportation planning.</td>
</tr>
</tbody>
</table>

NOTE: GIS = geographic information systems; TSMO = transportation systems management and operations; CAV = connected and automated vehicles; ICM = integrated corridor management; DRSC = dedicated short-range communications; CIM = civil information modeling.
need staff with advanced modeling and simulation skillsets for planning for operations and assessing impacts.

- **Emerging Technologies Industry Liaison.** Several organizations have identified a need for an industry liaison to facilitate collaboration among local private-sector technology companies and government agencies, recognizing the direct benefits of new approaches to solving problems and a less-direct economic development impact.

- **Transportation Systems Performance Manager.** Telling the story of how the transportation system is functioning, both in real time and over a longer period, has been critical to demonstrating the benefits of TSMO. A performance manager sees the big picture and can demonstrate the collective benefits of the various functions of TSMO.

- **Integrated Corridor Management Manager.** As management of freeways and arterial networks converge, it is important to have dedicated staff overseeing the strategies across facilities that promote safety while improving corridorwide mobility.

- **TMC Manager.** Although many government agencies have TMC managers that oversee staff in daily operations reacting to incidents and other events, the growth of CAV and other technologies within a control-room environment will require an added level of sophistication and understanding of how different actions affect network operations.

Several of the new positions described, such as cybersecurity engineer and AI scientist, may be extended to fit into a transportation organization’s overall information system and technology strategy and would thereby further strengthen the case for the position.

Government transportation organizations need to rethink how to recruit for emerging TSMO positions. For example, they may need to leverage use of professional organizations outside the typical transportation space to advertise for specialists.

- **Surface Weather Specialist.** As climate change continues to affect the transportation network, engaging weather specialists within a traffic management center (TMC) environment will aid in understanding the impacts and improving responses.

- **Systems Engineer.** As software, hardware, and communications networks become more complicated, it will become even more vital to have expertise on how all the pieces interact with one another.

- **TSMO Modeling Specialist.** As integrated corridor management strategies become more prevalent, agencies will

![FIGURE 1 Positions by impact to CMM maturity.](image)
Organizations also need to recognize that new, specialized positions may require relying on the private sector and university partners, which tend to have more flexibility with new types of contracting and working with nontraditional disciplines.

**Conclusion**

The work of the NCHRP Project 20-07(408) has culminated in a guidebook that provides human resource staff and others tasked with defining new positions a comprehensive resource to begin rethinking TSMO positions, evaluate potential impact on the agency, identify training resources, and provide guidance needed to take the initial steps in recruiting a capable TSMO workforce.

**REFERENCES**


As illustrated in several articles in this issue of TR News, many factors accelerate the demand for maintenance workforce development efforts. For instance, Todd Szymkowski and Stephanie Ivey discuss the evolving need for expertise in electrical and electronic systems to support transportation systems management and operations activities. Teresa Adams, Maria Hart, and Kerri Phillips recognize the urgency of providing advancement opportunities to retain skilled workers, especially since many transportation agencies face large numbers of retiring workers. Additionally, the increased focus on performance-based decision making in transportation agencies often requires change management efforts that focus on leadership development and workforce training.

For maintenance workers, an important part of training and development includes providing the skills necessary to use performance data for maintenance budgeting and using technology effectively in the field to track maintenance activities in real time. The use of technology was a key focus at a recent peer exchange that brought together maintenance practitioners from 27 state departments of transportation (DOTs) to exchange best practices in using technology and data to build performance-based maintenance programs.

The peer exchange was sponsored by the U.S. Domestic Scan Program, based on a recommendation from a 2015 domestic scan that investigated leading management practices used by state DOTs to determine adequate funding levels for maintenance and to allocate available funding at the district and regional levels to achieve performance objectives and increase accountability.

The findings from the peer exchange identified several workforce-related issues in maintenance and the use of maintenance quality assurance (MQA) programs to support performance-based decisions:

- Staff turnover and workforce reductions in maintenance departments put MQA programs at risk because of a general lack of understanding regarding how maintenance performance data are used to support decisions and how the lack of good-quality data hinders an agency’s ability to manage maintenance programs effectively. Participants left the peer exchange with a better understanding of the importance of MQA programs and their value to collected data.
- Colorado, Washington State, and Utah DOTs each have formal maintenance training programs in place to develop the leadership skills of their maintenance workforce. The Maintenance Leadership Academy, provided by the Federal Highway Administration’s National Highway Institute, is offered annually by several state DOTs to develop the leadership skills required of their maintenance supervisors to support the agencies’ performance-based management philosophies.
- Gaps exist between the skills needed by maintenance workers today and those needed in the past. One agency shared that in the past, maintenance crews had strong skills in operating and maintaining equipment. Today, that agency must train new maintenance workers in operating equipment. Washington State DOT has successfully initiated a two-way training program to address these gaps. The program pairs experienced and inexperienced maintenance personnel to develop the field skills of the newer workers and to get experienced workers more comfortable with using technology.
- Maintenance departments are adding data analysts and programmers to their teams to improve the way data are used to make decisions.
- Map-based interfaces and touch-screen applications on tablets are revolutionizing the way maintenance inventories are updated. Work activities now can be entered in real time and shared throughout the agency. Several DOTs are using lidar-equipped vans to collect and update asset inventory data; the use of drones also is being explored.

Although many agencies have relied heavily on traditional workforce development activities, such as instructor-led or online training, the peer exchange demonstrated another means of building an understanding among agency managers of how their agency’s capabilities must evolve to embrace the changing world.
Highway department workers perform many different tasks. The breadth of what they do is quite impressive and includes bridge deck overlays, road building, storm sewer work, concrete work, excavation, grading, tree removal, landscaping, sign installation, pavement markings, lighting, road maintenance, and more. These workers are expected to change tasks quickly if a higher priority arises and to operate a wide range of equipment—snowplows, mowers, forklifts, aerial buckets, excavators, materials testing equipment, compressors, asphalt pavers, graders, and office equipment. For their health and safety, workers need to know safe chainsaw operation techniques, ladder and climbing safety, CPR and first aid, respirator protection, and emergency action plans, and must have a clean driving record. For wellness and productivity, workers need to stay physically fit. Finally, maintenance workers have an important role in emergency response to weather or traffic incidents.

Across the country, many state departments of transportation (DOTs) say that filling highway maintenance positions is their biggest workforce challenge. According to the Federal Highway Administration’s (FHWA’s) Center for Local Aid Support, so-called “maintenance skills” are lacking in highway maintenance teams at almost every jurisdiction level (1).

Developing a Workforce Vision
Who will maintain the nation’s transportation infrastructure? The University of Wisconsin–Madison’s Midwest Transportation Workforce Center (MTWC) mapped career pathways for skilled occupations in the field and found that many employers cannot find qualified applicants for entry-level occupations—the gateways into the discipline. In response, the center worked with stakeholders to develop a vision to better understand and address the need for skilled and unskilled highway workers at a time when finding and retaining qualified workers is increasingly difficult.
A survey of workforce development practices indicated that, to achieve this vision, employers need to take a leadership role in creating the talent pipeline of the workers they need. The highway maintenance occupation is ideal for apprenticeship—a proven, employer-driven strategy for recruiting, training, and retaining workers.

**APPRENTICESHIP**

An apprenticeship is a post-secondary program, like college or university. The major differences are that apprentices learn only a portion of their skills in a traditional classroom and that employment is the primary requirement. Apprentices receive most of their training on the job while working for an employer, being mentored by an experienced coworker, and earning a wage.

MTWC worked with highway maintenance employers in Wisconsin’s counties and cities to define the curriculum for a new apprenticeship in highway maintenance. This article summarizes findings gathered through surveys, interviews, and data analysis and the resulting apprenticeship curriculum model. Specifically, MTWC focused on what it would take to implement apprenticeships to address the highway maintenance workforce needs as identified by hiring managers (2). At present, the state Bureau of Apprenticeship Standards and the Wisconsin Technical College System are working to implement apprenticeships for this occupation in the state of Wisconsin. The end goal is to provide a model that can be scaled and replicated across the country.

**HIGHWAY MAINTENANCE CAREER PATHWAY INITIATIVE**

Career pathways—a series of connected educational experiences and support strategies aimed at helping students achieve success—are a key component to addressing workforce challenges. MTWC’s work to develop career pathways for highway maintenance occupations is part of the National Transportation Career Pathways Initiative, an FHWA project to develop pathway models that transportation employers can implement in collaboration with community colleges, universities, and workforce development agencies.¹

MTWC began by engaging experts in the field and researching hiring trends and traditional career trajectories. In Figure 1

1 For more information, visit http://nntw.org/career-pathways.

Vision for a Highway Maintenance Career Pathway

A well-defined pathway to highway maintenance engineering (HME) careers exists in every state.

The HME career pathway is rich with opportunities to develop a technologically innovative workforce.

The HME career pathway is engaging, challenging, and innovative and provides entry points from many levels to encourage diversity.

(page 40), many jobs in the middle two bands require more than a high-school diploma but do not require a 4-year degree (3). These middle-skill jobs require some job-specific specialized skills that must be acquired on the job or in post-secondary or technical-school classes.

Many middle-skill jobs—for example, large vehicle mechanic—are highly specialized. For this reason, there tends to be very little career awareness or counseling to help people envision a career path or to determine the kind of experience and training that is required. For example, a worker in a repair shop could, by acquiring some work experience and additional training, eventually become a fleet manager.

MTWC found that many workers who learn on the job gain experience and skills but do not satisfy the educational requirements to advance in a career or to jump to another position. It is unclear how to articulate, or translate, the competencies, training, credentials, or experiences of highway workers into education credits for career advancement. MTWC looked for ways to provide this clarity through career pathways. Is it possible to facilitate the movement of a worker from entry-level laborer to highway maintenance manager, or to civil engineering technician and on to engineer?
Middle-Skill Gap

Middle-skill jobs, or jobs that require some postsecondary training or education but not a college degree, account for approximately half of the U.S. labor market. A middle-skill gap occurs when there is a mismatch between the skills of the workers in the talent pool and the skills required to accomplish job tasks.

Many critical highway maintenance occupations fall into this category because they require specialized knowledge, skills, and competencies. Some post-secondary education is required to be able to understand road maintenance techniques and tasks like confined entry, trenching and excavating, equipment operation, and equipment maintenance and repair. In fact, highway maintenance occupations require many skills that can demand higher wages in other occupations.

FAST-MOVING CHANGES

Middle-skill transportation occupations involve a lot of rapidly changing technology. For example, workers increasingly operate automated equipment and use tablet computers in the field. Connected and automated vehicle technology soon will change the role of transportation infrastructure and maintenance priorities. Maintenance crews will maintain infrastructure systems that support new types of vehicles, such as driverless cars, and will be responsible for installing, maintaining, and repairing a growing number of technological devices in and around the highway infrastructure. Increasing evidence of the human and environmental health impacts of transportation will change strategies and procedures for maintaining drainage and roadside ecosystems. The shrinking workforce will make equipment automation necessary and incumbent workers will need to acquire new skills to be able to operate the new equipment.

NEED FOR FORMAL TRAINING

MTWC’s research found a lack of formal training for middle-skill highway maintenance jobs, as well as no nationally recognized credential, for highway maintenance workers. Training in most workplaces is done on the job under the supervision of a more experienced coworker, but this is not consistent from one place to another. Without formalized training, the workplace is less safe. At a meeting of Wisconsin employers, the importance of consistent training across the workforce to ensure safety was highlighted.

“I need our workers to be the safest people out there,” explained Ric Mohelnitzky, superintendent of public works in the City of Wausau, Wisconsin. “We’re digging around gas lines. We look at what accidents could happen if we do not have the right training in place.”
Many of the skills and knowledge required for highway maintenance have been defined, and training courses are available from organizations like the Transportation Curriculum Coordination Council, the American Public Works Association, and the National Highway Institute. However, these training programs do not articulate toward credits that can be used to satisfy college degree requirements. Apprenticeship offers an efficient path to higher education. It comes with portable credentials that can be articulated toward an associate degree, allowing workers to further leverage their training as they advance in their careers.

Without education and training, workers often find their careers stalled. MTWC interviewed and surveyed incumbent managers about their career-related regrets. A common regret was that they had not pursued formal education. Further, many expressed that they had faced roadblocks in their career caused by a lack of the credentials needed—for example, leadership or financial management training—for the next step on the career ladder.

Success as Employer-Driven

How will the demand for more highway maintenance workers be satisfied when other broad labor trends already challenge employers’ ability to keep positions filled? A talent pipeline strategy helps employers identify the educational institutions from which they draw talent and to work with those institutions to accelerate training for unfilled jobs (4).

For example, Colorado DOT followed this approach when they collaborated with a community college to create the nation’s first associate’s degree in highway maintenance management. This degree is geared toward highway maintenance supervisors and those wishing to advance in the organization or to be better prepared for supervisory positions.

Online courses available through the Transportation Curriculum Coordination Council.

For workers, the training and educational requirements for middle-skill occupations, and how to go about getting them, are often unclear (3). Apprenticeships address this by providing portable credentials that have meaning beyond one’s current position.

Apprenticeship Delivers Return on Investment

In 2009, the Field Services Department in the City of Edmond, Oklahoma, developed their cross-training program for street, water line, and wastewater line maintenance into a registered apprenticeship program approved by the U.S. Department of Labor. Through this apprenticeship program, the city benefited from improved recruitment and retention as well as reduced costs from litigation and not having to hire consultants.

After one flooding event, the city saved an estimated $250,000 by not having to hire private contractors. “We got 11 inches of rain in less than an hour. We lost sewer lines. We lost all kinds of things,” said field services superintendent Keith Stewart. “Typically, the city would have hired contractors to come in and repair all of that stuff, but because our employees were properly trained and were confident in their ability, the work was completed in-house. After our employees had gone through the training, they had that confidence to do the work themselves.”

The program has correlated directly with an 80% reduction in tort claims and 60% reduction in workers’ compensation claims because the team is working more safely. The City of Edmond also improved employee recruitment and retention by providing staff with clear pathways to advance from entry-level trainee positions through technician to journeyman and specialist positions.
Apprenticeship is another excellent example of a talent pipeline management strategy that works particularly well for middle-skill occupations. Many employers of highway maintenance workers are not aware of the apprenticeship option, however.

In August 2018, MTWC hosted a meeting with the Bureau of Apprenticeship Standards at the Wisconsin Department of Workforce Development (DWD-BAS) that convened employers from across the state. They discussed how apprenticeship might address challenges in hiring, training, and retention in highway maintenance positions across Wisconsin municipalities. The next step for employers was to assemble an expert panel to conduct DACUM, or “Developing a Curriculum”—a process to capture the major duties and related tasks included in an occupation, as well as necessary knowledge, skills, and traits—of the Roadway Maintenance Technician occupation in Wisconsin.

The first step was to assemble an expert panel to conduct DACUM, or “Developing a Curriculum”—a process to capture the major duties and related tasks included in an occupation, as well as necessary knowledge, skills, and traits—of the Roadway Maintenance Technician occupation in Wisconsin. After that, the Wisconsin Technical College System and DWD-BAS will create an apprenticeship.

Employers realize benefits from apprenticeship programs in addition to growing needed talent—they spend less on recruitment and training if they can retain their workforce. Overall, the return on investment from apprenticeship is positive, with returns averaging from $0.50 to $11 for every dollar invested (5).

Bringing Apprenticeship to Highway Maintenance

The benefits of apprenticeship are clear, yet the adoption of this strategy by many transportation occupations has lagged behind other industries. MTWC sees an opportunity to apply apprenticeship to highway maintenance middle-skill occupations. MTWC has collaborated with DWD-BAS to develop and deploy a highway maintenance apprenticeship in Wisconsin.

The first step was to assemble an expert panel to conduct DACUM, or “Developing a Curriculum”—a process to capture the major duties and related tasks included in an occupation, as well as necessary knowledge, skills, and traits—of the Roadway Maintenance Technician occupation in Wisconsin.

Next, the broader community of maintenance professionals from counties, cities, and towns throughout the state were invited to share their feedback on the DACUM results. Fifty people completed a validation survey; more than half were roadway maintenance supervisors and the rest were public works directors, commissioners, and city engineers.

In the DACUM, the Roadway Maintenance Technician occupation has nine major responsibilities:
1. Perform structure maintenance,
2. Perform pavement maintenance,
3. Perform basic equipment operation and safety,
4. Manage vegetation,
5. Manage stormwater and drainage facilities,
6. Maintain winter roadways,
7. Install and maintain signs and pavement markings,
8. Establish work zones, and
9. Demonstrate professional skills.

The scope of these responsibilities is relevant to a county highway department, falling between the duties of a municipal department of public works and of a highway construction crew. Municipal public works departments work with utility infrastructure, pavements, curbs and gutters, trees, sidewalks, and the like, and require a much broader and more diverse knowledge base. Equipment operations and safety knowledge, as well as profes-
**COLOR KEY**

- **Apprentices learn these tasks on the job and through related classroom training instruction on equipment use and procedures, technology, standards, and safety.**
- **Apprentices learn these tasks on the job with related classroom instruction on equipment use, interpreting information, and decision-making.**
- **Apprentices learn these tasks on the job with some related classroom instruction and training on data entry, reporting, and maintenance procedures.**
- **Apprentices learn these tasks on the job with minor related classroom instruction or training.**

### Professional Skills
- Apply MUTCD standards
- Interpret maps and blueprints
- Set grade and alignment
- Interact with the public, coworkers, and elected officials
- Use computers and mobile devices to perform job functions
- Record labor, equipment, and materials

### Manage Stormwater and Drainage Facilities
- Record maintenance activities
- Install culverts
- Install and maintain storm sewers
- Monitor and deploy flood control devices
- Maintain stormwater facilities
- Grade road shoulders
- Grade road ditches
- Inspect and clean drainage structures
- Repair drainage washouts
- Perform street sweeping
- Clean stormwater inlets and outlets
- Rebuild catch basins and manholes
- Report washouts and deficiencies

### Basic Equipment Operation and Safety
- Wear personal protective equipment.
- Comply with Safety Data Sheet requirements
- Perform pre- and post-trip equipment inspection
- Distribute and secure loads for hauling
- Perform daily preventative maintenance on equipment

### Install and Maintain Signs and Pavement Markings
- Verify location of utilities
- Fabricate traffic signs
- Inspect signs and pavement markings
- Paint longitudinal pavement lines
- Install posts and signs
- Verify sign location
- Record sign maintenance
- Repair damaged signs
- Paint special pavement markings

### Perform Structure Maintenance
- Inspect road structure
- Report structure maintenance
- Report structure deficiencies
- Perform bridge deck repairs
- Perform erosion control
- Perform understructure bridge repairs
- Seal bridge decks
- Build, repair, and replace retaining walls
- Repair and replace appurtenances
- Replace guardrails and impact attenuators
- Remove graffiti
- Clean bridge components
- Paint bridge components

### Perform Pavement Maintenance
- Verify documented location of utilities
- Perform chip sealing
- Determine quantities of material needed
- Determine type of repair needed
- Remove and replace pavement
- Replace failed joints
- Perform crack and joint filling
- Select and inspect equipment needed
- Replace curb and gutter
- Perform pothole repair

**FIGURE 2** Major responsibilities in highway maintenance, broken into tasks.
sionalism, is necessary at highway and public works agencies.

Figure 2 (page 43) shows the highway maintenance tasks in each responsibility category. Each task is color-coded to indicate its relative difficulty and where an apprentice would learn it; for example, an apprenticeship program most likely would include classroom learning for the yellow and orange tasks. These tasks require apprentices to use specialized equipment properly, interpret drawings and weather maps, apply standards, and make procedural decisions.

Many of the responsibilities are seasonal in nature. Tasks related to the maintenance of highway structures are performed from spring to early fall. Tasks for maintaining pavements, vegetation, drainages, signs, and markings occur throughout the year. Winter maintenance tasks are heavily dependent on the weather. Some counties in the state contract for bridge maintenance work rather than use in-house personnel.

The broader community rates each task on frequency and difficulty, averages of which were multiplied to determine the most frequent and difficult tasks combined. The top 10 of these tasks are listed in Table 1 (at left). This rating helps educators determine training priorities—for example, the ability to operate a snowplow is essential in Wisconsin and precise operation is an admired talent.

Interestingly, most of the other top tasks require workers to apply basic knowledge of highway engineering technologies, materials, and standards.

Tasks have different levels of difficulty depending on the level of expertise required to perform the task. Difficulty can relate to learning the task or to performing it correctly. These highway maintenance tasks range from the straightforward, which do not require special skills or knowledge (not difficult), to those mastered with minimal practice (somewhat difficult), to those that are moderately difficult. Moderately difficult tasks require the ability to transfer knowledge from one area to another. None of the tasks requires in-depth training or considerable experience.

Apprenticeship can be the first step in a career path that includes a degree. For example, as shown in Figure 3 (at left), apprentices who complete a Wisconsin Highway Maintenance Registered Apprenticeship program may receive up to 39 credits toward an associate degree at one of the schools in the Wisconsin Technical College System.

Furthermore, the members of the Registered Apprenticeship College Consortium (RACC), a national network of colleges, agree to accept degree credit toward an associate’s degree for a certificate of completion from other RACC members. For example, because Front Range Community College—which has an associate’s degree program in highway maintenance

### TABLE 1 Top 10 Highway Maintenance Tasks Based on Frequency and Difficulty Ratings

<table>
<thead>
<tr>
<th>Rank</th>
<th>Task Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Plow snow and ice from roadways</td>
</tr>
<tr>
<td>2</td>
<td>Interact professionally with coworkers, elected officials, and the public</td>
</tr>
<tr>
<td>3</td>
<td>Determine quantities of material needed</td>
</tr>
<tr>
<td>4</td>
<td>Determine type of repair needed</td>
</tr>
<tr>
<td>5</td>
<td>Manage materials application</td>
</tr>
<tr>
<td>6</td>
<td>Apply MUTCD standards</td>
</tr>
<tr>
<td>7</td>
<td>Select equipment and materials needed for work zone</td>
</tr>
<tr>
<td>8</td>
<td>Select and inspect equipment needed</td>
</tr>
<tr>
<td>9</td>
<td>Inspect and monitor snow-removal equipment</td>
</tr>
<tr>
<td>10</td>
<td>Use computer and mobile devices to perform job functions</td>
</tr>
</tbody>
</table>

NOTE: MUTCD = Manual on Uniform Traffic Control Devices

**FIGURE 3** A roadmap from highway maintenance apprenticeship to degree.
Minnesota Department of Transportation (DOT) deployed the concept of developing continuity books to share knowledge about documented processes and information resources within the agency, along with “just in time” training videos. These knowledge books are used to capture deep technical expertise from key subject-area experts at Minnesota DOT who have developed their expertise over many years of experience and educational background. Knowledge books are an important tool to ensure that deep institutional expertise does not disappear upon the retirement of these technical experts.

More recently, knowledge books have been developed based on the MASK system. MASK, or Method of Analysis and Structuring Knowledge, is an evolution of the Method for Knowledge System Management and is based on the same principles. The MASK method offers a flexible environment to facilitate successful knowledge capitalization projects, guiding experts to describe their focus area by emphasizing its main characteristics. It has been applied in many domains that have allowed its evolution, including safety, business process, and mechanical design.

So far, Minnesota DOT’s knowledge books have been developed in the subject areas of concrete and bituminous paving and mix designs, including the identification of deleterious aggregates, and steel bridge construction. The books began as interactive PowerPoints and further work is being conducted to make them more accessible to the public and to ensure they comply with the Americans with Disabilities Act.

Once complete, the public-sector MASK knowledge books will be ready for debut.

Future for Highway Maintenance Careers

In the future, MTWC envisions that young people will be aware of and interested in the highway maintenance discipline. With the implementation of initiatives such as a career pathway supported by apprenticeship in highway maintenance, employers can overcome challenges related to a shrinking workforce and a poor image and begin to grow the talent they need to keep the nation’s highways in good repair today and into the future.¹

¹ For more information on apprenticeships, please visit MTWC’s webinar series, “Accelerating Apprenticeship in the Transportation Sector,” at http://mtwc.org/mtwc-events/apprenticeship/

REFERENCES


In her six years as Chief Administrative Officer (CAO) for the Idaho Transportation Department (ITD), Charlene (Char) McArthur has led ITD’s strategic innovation team. One of her early insights was that the prior focus had been on doing innovative things instead of creating an innovative organization. A shift in focus resulted in the creation of Innovate ITD!, an effort that has generated more than 1,500 ideas and $10 million in taxpayer savings since 2014. In 2016, ITD was selected by the Idaho Technology Council as one of three finalists for Innovative Company of the Year. Earlier in her career, McArthur cut her teeth on small start-up and turn-around operations, progressively growing into a Fortune 200 multinational organization at which she amassed critical thinking and strategic innovation experience. McArthur also authored one of the articles in this issue of TR News.

As CAO, McArthur functionally oversees technology, finance, continuous improvement, procurement, and other administrative services. As ITD’s executive innovation strategy champion, McArthur focuses the innovation effort to emphasize the core of the workplace—its culture. “ITD leadership is intensely focused on creating a culture where employees want to work, so we attract and retain employees that create desired outcomes,” she notes. “Our innovation approach is differentiated by our focus on the cultural aspect of innovation first, and the outcome and process aspects second. Creating an organization that inspires innovative people, rather than completing a checklist of innovative things, requires change at many levels, specifically change in behaviors, which is the heart of culture.”

A native of Boise, Idaho, McArthur graduated from Boise State University (BSU) in 1987 with a bachelor’s degree in accounting. She has worked in public accounting and in private industry and is a licensed CPA in Idaho. McArthur mentors students at her alma mater, BSU, and coaches human-centered design thinking project teams at One Stone High School in Boise. She is a member of the Treasure Valley CFO forum and serves as the ITD delegate to the Idaho Technology Authority board, which sets state IT policy.

McArthur has presented on innovation, human-centered design thinking, leadership, culture, and lean transformation to TRB, the Association of Government Accountants, the Western Association of State Highway Transportation Officials, the National Transportation Leadership Institute, and the National Transportation Advanced Leadership Institute. She also serves on National Cooperative Highway Research Program (NCHRP) project panels on effective practices for creating and maintaining an innovation delivery culture and on capturing the value of NCHRP research.

Char is a member of the TRB Standing Committee on Management and Productivity and several American Association of State Highway and Transportation Officials committees. She also serves as an Idaho delegate to the Pacific Northwest Economic Region.

“Research is in our blood. Our fundamental nature as scientific beings is to observe, question, hypothesize, predict, and test new things, the essence of research. A society without research is a society without advancement, or even understanding, of the world around it.” McArthur observes. “Yet, the current political and budgetary pressures of today create more scrutiny of the value of transportation research. Research approaches need to evolve. Proven concepts to improve throughput and outcomes should be considered to modernize our research approaches.”

One strategy to address the big question of research efficiency—to address efficiency questions of any size, McArthur adds—is “centralization of efforts with common goals.” Centralization creates information sharing and the cooperation of many entities in accomplishing outcomes. “If every entity, federal or local, had to discover and research on their own, the waste would be tremendous. Privatized research, although it may advance more rapidly than government-funded research, is usually coveted and exploited for profit rather than the good of society,” she continues. “It is imperative we become more effective through cooperative and shared research to optimize our outcomes in government-funded efforts.”

An avid proponent of process improvement—that is, finding better ways to accomplish outcomes—McArthur notes that society’s demand for instant gratification make it incumbent on the research profession to respond to this demand by adapting age-old process models to evolve and survive. McArthur believes that “there is no more exciting time to be involved in transportation than right now. The possibilities for the future are limited only by our imagination. Transportation changes we are creating today will affect how people live—their health, their social interactions, and their quality of life—for decades to come.”
Framing the Challenge of Urban Flooding in the United States

LAUREN ALEXANDER AUGUSTINE AND ANNE LINN

Augustine is Executive Director, Gulf Research Program, and Linn is Senior Program Officer, Board on Earth Sciences and Resources, National Academies of Sciences, Engineering, and Medicine, Washington, D.C.

At the request of the Federal Emergency Management Agency (FEMA), the National Academies of Sciences, Engineering, and Medicine created the Committee on Urban Flooding in the United States. The study conducted workshops with local residents in four metropolitan areas to understand the causes and impacts of urban flooding, gathering information to identify commonalities and variances in the causes, impacts, and management of urban floods among the areas; estimates of the size or importance of flooding in those urban areas; and ways that urban flooding issues relate to federal resources.

Discussions at the workshops and meetings were organized around the four dimensions of urban flooding:

1. **Physical**: built and natural environments,
2. **Social**: impacts on people,
3. **Information**: data used to understand or communicate flood events, and
4. **Actions and decision-making**: steps and policies for managing flooding.

The committee selected four metropolitan areas as case studies: Baltimore City and Baltimore County in Maryland, the City of Chicago and Cook County in Illinois, the City of Houston and Harris County in Texas, and the City of Phoenix and Maricopa County in Arizona. These cities were selected based on the flooding characteristics of many urban areas in the United States.

The committee was not charged with a specific transportation-related objective, but the role of transportation emerged during the workshops and case studies. This article highlights parts of the report that discuss transportation as related to effects of urban flooding.

**DEFINING URBAN FLOODING**

Urban flooding is caused when the inflow of stormwater in urban areas exceeds the capacity of drainage systems to infiltrate stormwater into the soil or to carry it away. The inflow of stormwater results from heavy rainfall, storm surges, or high tides. Floodwater inundation and movement are influenced by 1) land development, which disturbs natural drainage patterns and creates hardened surfaces that inhibit infiltration of stormwater, and 2) stormwater systems that are undersized for current needs and increase exposure to drainage hazards.

To understand the origins of urban flooding today, it is necessary to first understand how flood problems reflect the history of a city and its urbanization. Many early U.S. cities were established along rivers and coasts (in this study, Baltimore and Chicago) to facilitate trade, support manufacturing, and transport people and goods. The growth of commerce and the availability of jobs and services drew people to these early settlements, a trend that accelerated with industrialization in the mid-19th century (7). Hard street surfaces for motor-driven transportation became common, and city engineers began to design and construct sewer systems to carry human waste and stormwater runoff away from homes and businesses. Cities began to grow outward with the help of steam powered trains, electric street trolleys, subways, and eventually cars.

**TYPES OF URBAN FLOODING IMPACTS**

Workshop participants in each metropolitan area described their area’s experiences with urban flooding. It is difficult, however,
to quantify the magnitude of urban flooding because flooding can result in a wide variety of economic, social, and ecological impacts, all of which vary geographically. Incomplete or uneven data pose a challenge to determining magnitude in quantitative terms. Types of impacts include the following:

1. **Direct impacts** are the immediate effects of the disaster; that is, loss of life or damage to buildings, roads, agriculture, and infrastructure.

2. **Indirect impacts** result from direct impacts in the medium to long term; that is, unemployment and reduced income that are due to business and transportation interruption.

3. **Tangible impacts** have a market value and generally can be measured in monetary terms; for example, structural losses.

4. **Intangible impacts** take place outside of the market; for example, impacts on health, natural resources, or the cohesion of a social group or community.

**COMPARING THE FOUR AREAS**

Stakeholders in all four metropolitan areas lamented a lack of data on urban flood hazards, including the economic costs and social impacts of urban flooding. In the absence of better information, managers and residents use FEMA’s Flood Insurance Rate Maps to estimate where flooding will occur in urban areas. Some metropolitan areas are working to augment the FEMA maps with more useful information about where, when, and the rate at which flooding is estimated to occur. For example, Harris County has developed local flood models and Maricopa County and its partners are producing flood maps for transportation and flood warning purposes.

A key difference among the case study areas was the sources of flooding: riverine (Baltimore), coastal (Baltimore, Houston, and Chicago), flash (Phoenix), and pluvial flooding (all four areas), as well as sewer backups (Chicago and Baltimore). Decisions about land development and design or maintenance of infrastructure—including roads—were seen to amplify the intensity and influence the location of flood impacts in each metropolitan area.

**COMMUNICATING URBAN FLOOD HAZARD AND FLOOD RISK**

The case study workshops highlighted that people want to understand flood risk and the effects on property, businesses, schools, and transportation to better manage their risk. Maps and visualizations are a primary means of communicating flood risk.

Ideally, these maps and visualizations would portray information on both the hazards (e.g., the likelihood of being flooded under different scenarios) and consequences (e.g., building damage and population exposure) as well as other information—such as land cover, distribution of socially vulnerable populations, and condition of roads—that could amplify or alter the risk. Geographic information systems offer one means for integrating these observations with predictions of flood inundation.

**EXAMPLES OF INSIGHTS FROM THE CASE STUDIES**

The Baltimore metropolitan region is subject to riverine, coastal, and flash flooding. Workshop participants identified contributors to flooding, including urbanization, aging storm and sewer infrastructure, subsidence and sea level rise, and poor building and flood mitigation practices. High concentrations of impervious surfaces and historical flood mitigation actions (e.g., burying streams) have altered natural drainage systems. Very old storm drains that collapse are the root cause of the sinkholes that open up across Baltimore after significant rains, creating road closures and other inconvenient or dangerous conditions. Sinkhole repair consumes almost all of Baltimore’s dedicated flood management resources.

In the Houston metropolitan area, small- and large-scale projects attempt to mitigate problems caused by flooding. Some of the small-scale projects include replacing inlets, sewer lines, and driveway culverts. A large-scale project in Houston—Project Brays, managed by the Harris County Flood Control District and the U.S. Army Corps of Engineers (USACE)—is estimated to cost at least $550 million. It seeks to widen 21 miles of the Brays Bayou, replace or modify 30 bridges, and create four detention basins to store stormwater.

Experts at the meeting also described instances of successful interagency coordination. For example, the Flood Control District of Maricopa County manages a
flood warning system to facilitate communication among multiple government jurisdictions. Four federal agencies—U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration, USACE, and FEMA—provide information to the Maricopa County Flood Control District and the Flood Control District provides information to other county departments, cities, and the Arizona Department of Transportation (DOT).

An example at the state level is Arizona DOT’s Transportation Resiliency Program, in which participating agencies share information, identify common problems and shared solutions, and develop policies and regulations to mitigate urban flooding. One such project is a 5-year, $1 million partnership with USGS. USGS monitors storms; collects data; and provides hardware, software, and capabilities to measure surface water flow, and Arizona DOT uses these assets to plan for and respond to floods.

CONCLUSION

The Committee on Urban Flooding in the United States found that urban flooding is a complex problem, with disparate and varying physical causes that leave distinct impacts on different urban centers. Impacts vary across the social spectrum, with vulnerable populations at higher risk. Data and information on these causes and impacts of urban flooding are not evenly captured at various levels of government or by different jurisdictions. Although it is clear that urban flooding is costly in some places (e.g., coastal cities), it is challenging to adequately quantify losses and other impacts or to focus resources for prevention and mitigation. The committee also found that responsibility for addressing urban flooding impacts is distributed across federal, state, and local government agencies and nongovernmental entities.

Considering these complexities, this issue requires a different management approach—multiagency and cross-jurisdictional efforts are needed to understand social impacts and effective interventions. Communicating that risk to the public will require new types of urban flood maps, tools, and visualizations. None of these efforts will be easy or cheap, but they are necessary to address the national problem of urban flooding.

REFERENCE


ACRP Champion Takes Off

The Airport Cooperative Research Program (ACRP) recently honored first-ever ACRP Champion Amber Leathers, Senior Planner at Charlotte Douglas International (CLT) Airport. ACRP Champions are early- to midcareer airport industry professionals nominated for the position by their organizations’ senior leaders to gain exposure to ACRP research and engagement opportunities. Over time, Champions become their organization’s in-house experts on ACRP.

As a Champion, Leathers’s work focused on completing six missions, each with different objectives: sharing and using ACRP research, collecting new research ideas, nominating colleagues to serve as project panelists, hosting webinars for aviation staff, capturing ACRP impacts on practice, and more.

Leathers served three years as CLT Airport’s ACRP Champion before “graduating” to the elite corps of ACRP Ambassadors, who disseminate ACRP research and promote engagement opportunities beyond her airport by speaking and exhibiting at industry conferences.

“I gained a lot of skills as an ACRP Champion, and I’m glad to have been a part of the program.”

―Ted Hogan, Eastern Research Group, Charlotte, North Carolina

(Left to right:) Marci A. Greenberger, ACRP Manager; Amber Leathers, Senior Planner, CLT Airport; and Jack Christine, Chief Operating Officer, CLT Airport. Leathers is the inaugural graduate of the ACRP Champion program and now serves as ACRP Ambassador at her airport.
100 Years of TRB

**CENTENNIAL WEBSITE LIVE**

TRB turns 100 in 2020. To support the value of transportation research and TRB’s critical role in the process, the TRB Centennial Celebration will recognize and honor volunteers, sponsors, major contributors, and staff; highlight TRB’s accomplishments and its sponsors’ roles in those accomplishments; celebrate and promote the TRB community; and elicit pride in TRB participation.

The newly launched Centennial website (www.trb.org/Centennial) offers information on the centennial goals and plan, how to contribute to the Century Club or become a Century patron, how to donate a TRB artifact, and more. The website also includes papers, submitted by more than 50 committees, detailing committee histories and accomplishments and examining incipient issues in their sectors.

The website also features a time capsule—a collection of reports and publications that address TRB history, from “A Proposed Program of Highway Research: Introduction” (1930) to “NCHRP at 50 Years” (2012) and more.

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**SHRP 2 Safety Data Bonanza**

**STUDENT PAPER COMPETITION 2017–2019**

The safety data collected via the second Strategic Highway Research Program (SHRP 2) are the result of the largest naturalistic driving study ever conducted. To encourage use of SHRP 2 safety data by graduate students, the Safety Data Bonanza competition was held from 2017 to 2019. The effort fostered the efforts of the next generation of leaders in surface transportation research.

Beginning in August 2017, the Safety Data Bonanza competition solicited innovative ideas for using safety data. A total of 26 students proposed ways they would use SHRP 2 data to address a research question. Research topics were drawn from a wide range of subjects of interest to the road safety research community, such as driver behavior and roadway geometric design. Several applications extended beyond road safety to such topics as transportation planning, traffic operations, and transportation modeling. After submittal, abstracts were ranked by a panel of judges and nine researchers were selected to move ahead to the next stage: writing a full-length research paper and presenting at a poster session at the TRB Annual Meeting in Washington, D.C., in January 2019. Reusable datasets were made available free of charge to competition researchers.

The Annual Meeting poster session offered an opportunity for the nine selected applicants to showcase their analysis and results to the large, diverse Annual Meeting audience. The competition paid for participants’ travel and conference costs. Eight of the nine graduate students selected to prepare full research papers were able to travel to Washington and showcase their research.

Research topics included work zones, driving in school zones, car following, deceleration lanes, driver characteristics, driving styles, predicting crashes and “near crashes,” structural equations in modeling safety, and benefits of connected and automated vehicles for older drivers. Universities represented included Arizona State University, Auburn University, Florida A&M University, Iowa State University, Louisiana State University, the State University of New York at Buffalo, the University of Florida, the University of Tennessee, and the University of Wyoming.

*TRB E-Circular E-C243, which contains four full papers selected by the judges, is now available at [www.trb.org/Main/Blurbs/179026.aspx](http://www.trb.org/Main/Blurbs/179026.aspx).*

—David Plazak

Associate Director, Safety Data, Transportation Research Board, Washington, D.C.

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**SHRP 2 Safety Data Bonanza**

Eight students presented at the SHRP 2 Safety Data poster session in January 2019. Presiding officer Joanne Harbluk, Transport Canada (at left), is a member of the Safety Data Oversight Committee, which sponsored the poster session.

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Wildlife Crossings a Success

In the five winters between 2010 and 2014, 282 mule deer and elk were hit by vehicles along SH-9 in Colorado. In 2015, the Colorado River South Wildlife & Safety Improvement Project installed seven large wildlife crossing structures and 10.4 miles of wildlife exclusion fence along the corridor to mitigate wildlife-vehicle collisions (WVC) and provide safe passage for animals. For the past 3 years, Colorado Department of Transportation (DOT) and the Colorado Parks and Wildlife (CPW) have monitored the results, finding success rates of up to 98% for animal crossings and a decrease of 89% in WVC.

To analyze the effectiveness of the wildlife crossings, Colorado DOT and CPW used 62 motion-triggered cameras to monitor wildlife activity at the crossings, escape ramps, guards, and exclusion fences and compared this with previous WVC rates and preconstruction monitoring in the project area. Over the course of the study, they found not only that animal crossings were successful, but also that the success rates increased over time as wildlife adjusted their movement patterns.

The study will continue as Colorado DOT and CPW use the results to adapt the structures and fencing and plan similar future projects.

To read the full report, visit www.codot.gov/programs/research/pdfs/2019/SH9Yr3.

Distracted Driving Crashes on the Rise

Although drunk driving crashes have fallen by a third in the past 30 years, rates of crashes related to distracted driving have risen. According to a 2019 report by Zendrive, the amount of time drivers are distracted by cellphones behind the wheel has doubled in the past year. Eight percent of drivers, whom the report classifies as addicted to cellphones, spend 28% of their driving time actively ignoring the road.

Zendrive analyzed more than 1.6 billion miles of driver data from 1.8 million drivers, using smartphone sensors and pattern analysis. Researchers surveyed 500 U.S. residents about their phone use while driving: the apps they use the most, their opinions on distracted driving, and how they rate themselves as drivers. The report includes information from a University of Utah case study on the impact of cell phone use on driving impairment and analyzes the impact of distracted driving laws on handheld phone use in all 50 states and 19 cities.

Drivers who use their cellphones on the road are more likely to crash and to drive more slowly; they are 9% slower in applying brakes, and their following distance varies 24% more than nondistracted drivers. Distracted drivers also outnumber drunk drivers and are on the roads during the busiest times of day.

To read more and download the full report, visit http://blog zendrive.com/2019 distracted-driving-study-phone-addicts-are-the-new-drunk-drivers/.

Safety Implications of Technology Names

A recent study from the Insurance Institute for Highway Safety explored the safety impacts of driver-assisted technology system names. Researchers asked more than 2,000 drivers what driving behavior they believed would be safe, based on the names of available driver-assisted technologies currently on the market, including Autopilot, Driving Assistant Plus, and ProPilot Assist. All of these systems are considered Level 2; that is, all require hands-on driving and none reliably manage lane-keeping or speed control in all situations.

When asked about Autopilot, 48% of respondents said they thought it would be safe to take their hands off the steering wheel. Just over half that number thought that removing their hands from the steering wheel would be safe with Driving Assistant Plus. Nearly 10% of respondents thought that watching a movie on a cellular device would be safe while using Autopilot.

To learn more about the study, visit www.iihs.org/news/detail/new-studies-highlight-driver-confusion-about-automated-systems.

Effects of Incentive Program on E-Bicycling

A study published in the Journal of Transport and Health evaluated an electric bicycle incentive program’s effectiveness on encouraging the switch from car to e-bike. Recruited by traditional and social media channels in the city of Noord-Brabant, Netherlands, participants in the program received monetary compensation depending on their e-bike usage; compensation increased during peak commuting hours. E-bike use had to constitute at least 50% of their weekly work trips previously taken by car and had to be a commute distance of at least 3 km.

Data were collected on participants through a smartphone app, questionnaires measuring behavioral change, and a satisfaction rating scale. Although the incentive program increased the use of e-bikes, about half of the e-bike trips replaced conventional bike trips rather than car trips, the study found. Commuters who already used multimodal transportation or occasionally used bicycles were more likely to replace car use with e-bikes; those with strong car-commuting habits were less likely to shift modes.

To read the study, visit www.sciencedirect.com/science/article/pii/S22141405173065647_rdoc=1&_fmt=high&_origin=gateway&_hor=msds=b8429449cccf9c30159a5f9aeaa92fbb.
These titles are not TRB publications. To order, contact the publisher listed.

**Transportation and Public Health: An Integrated Approach to Policy, Planning, and Implementation, 1st Edition**


This volume helps transportation professionals to integrate public health considerations into transportation planning, supporting sustainability and promoting societal health.

**Data and Methods to Understand Travel**

Transportation Research Record 2672, Issue 42

Application of the “foot-in-the-door” compliance technique, factors affecting interview duration in web-based travel surveys, and application of the gap bootstrap are among the topics examined in this issue. 2018; 301 pp. For more information, visit http://journals.sagepub.com/home/trr.

**Traffic Monitoring: Automobiles, Trucks, Bicycles, and Pedestrians**

Transportation Research Record 2672, Issue 43

Research on methods, challenges, and evaluations of traffic monitoring across modes of travel are addressed in this issue.

**Managing Performance and Assets; Freight Data and Visualization**

Transportation Research Record 2672, Issue 44

This issue presents research on long-distance, multimodal freight; performance metrics for corridor evaluation; traffic simulations; and topics related to managing performance.

The workshop was the first in a series of follow-up activities to an NAE workshop earlier in the year that examined the relationship between engineering societies and engineering education. That workshop looked at “potential areas where engineering societies could contribute in significant ways that align with the needs of engineering education,” said Leah Jamieson of Purdue University, chair of the project steering committee.

The goal of this workshop was to develop a shared understanding of what a competition might look like, said Burt Dicht of Institute of Electrical and Electronics Engineers, a workshop organizer. B. L. Ramakrishna, director of the NAE Grand Challenges Scholars Program Network, noted that his position at NAE was created to support students working on the Grand Challenges from a local to a global scale. The Grand Challenges Scholars Program gives students the opportunity “to realize their dreams and goals” and to provide future employers with graduates who have a global, entrepreneurial, and socially oriented mindset.

The workshop consisted largely of breakout sessions in which small groups discussed six topics: value propositions, competition concepts, judging criteria, society commitments, implementation, and communications. In plenary sessions, representatives reported the groups’ ideas and conclusions, including aspects requiring further consideration. In a final plenary session, the workshop participants discussed issues still to be resolved.

Articles for Issues 1–8 of TRR Volume 2673 (2019) are now online. Beginning this year, TRR will publish one interdisciplinary issue monthly. Individual articles will be released as available and compiled into the issue at the end of the month. Readers will be able to choose to access either the complete issue or individual articles. For more information, visit http://journals.sagepub.com/home/trr.

Information Technology, Geospatial Information, and Advanced Computing
Transportation Research Record 2672, Issue 45
Articles in this issue include performance of hyperspectral imaging with drone swarms, WiFi scanner technologies for obtaining travel data about circulator bus passengers, and wireless magnetometers for stop bar detection at signalized intersections.
2018; 304 pp. For more information, visit http://journals.sagepub.com/home/trr.

Geotechnical Asset Management for Transportation Agencies, Volumes 1 and 2
NCHRP Research Report 903
This two-volume report offers a research overview and scalable guidance for state transportation agencies on implementing risk-based geotechnical asset management into current management plans. Downloadable planners, examples, templates, and training guides are included.
2019; 196 pp.; TRB affiliates, $69.75; nonaffiliates, $93. Subscriber categories: administration and management, bridges and other structures, geotechnology.

Measuring the Effectiveness of Public Involvement in Transportation Planning and Project Development
NCHRP Research Report 905
Provided in this volume is a field-validated and practitioner-ready toolkit to measure the effectiveness of a transportation agency’s public involvement activities.
2019; 102 pp.; TRB affiliates, $54; nonaffiliates, $72. Subscriber categories: planning and forecasting, society.

Acceptance Criteria of Complete Joint Penetration Steel Bridge Welds Evaluated Using Enhanced Ultrasonic Methods
NCHRP Research Report 908
This report presents proposed modifications to the AASHTO/AWS D1.5 code for acceptance criteria for complete joint penetration welds in steel bridges. These updated guidelines reflect newer enhanced ultrasonic testing methods.
2019; 84 pp.; TRB affiliates, $51.75; nonaffiliates, $69. Subscriber category: bridges and other structures.

Guide to Truck Activity Data for Emissions Modeling
NCHRP Research Report 909
Explored in this report are methods, procedures, and data sets needed to capture commercial vehicle activity, vehicle characteristics, and operations to help estimate and forecast pollutants, air toxins, and greenhouse gas emissions from goods and services movement.
2019; 76 pp.; TRB affiliates, $50.25; nonaffiliates, $67. Subscriber categories: motor carriers, environment, vehicles and equipment.

Design Guidelines for Horizontal Sightline Offsets
NCHRP Research Report 910
Authors present guidance for addressing the types of sight distance restrictions most likely to be encountered on specific roadway types, specifically on horizontal curves and a sight obstruction. An Excel spreadsheet to calculate sight distance is included.

Managing State Transportation Research Programs
NCHRP Synthesis 522
This synthesis identifies the current state of practice in managing state transportation research programs. Highlighted are existing resources, desired individual skill sets, core competencies, and structures for departments to manage and conduct transportation research, especially federally funded research.
2019; 172 pp.; TRB affiliates, $68.25; nonaffiliates, $91. Subscriber categories: research, transportation, general.

Resilience in Transportation Planning, Engineering, Management, Policy, and Administration
NCHRP Synthesis 527
Documented in this synthesis are resilience efforts and how they are organized, understood, and implemented within transportation agencies’ core functions and services. A survey of state departments of transportation (DOTs) accompanies the report.
2018; 82 pp.; TRB affiliates, $50.25; nonaffiliates, $67. Subscriber categories: planning and forecasting, policy, security and emergencies.

Analyzing Data for Measuring Transportation Performance by State DOTs and MPOs
NCHRP Synthesis 528
This synthesis summarizes the data management knowledge and practice used by state DOTs and metropolitan planning organizations and how these agencies measure transportation performance.
2018; 62 pp.; TRB affiliates, $45; nonaffiliates, $60. Subscriber categories: administration and management, data and information technology.
Automated Pavement Condition Surveys
NCHRP Synthesis 531
Documented in this synthesis are agency practices, challenges, and successes in conducting automated pavement condition surveys. Included are three case examples. 2019; 122 pp.; TRB affiliates, $57; nonaffiliates, $76. Subscriber categories: highways, maintenance and preservation, pavements.

Wetland Mitigation
ACRP Research Report 198, Volumes 1–2
This two-volume report explores how to mitigate potential impacts to wetlands from airport construction, expansion, and safety improvements. Volume 1: Executive Summary presents an overview of the broad range of issues. Volume 2: A Guidebook for Airports defines types of jurisdictional wetlands as well as methods and procedures to balance aviation concerns and environmental objectives. 2019; 188 pp.; TRB affiliates, $63.75; nonaffiliates, $85. Subscriber categories: aviation, environment.

Guidebook for Managing Small Airports
ACRP Research Report 16, 2nd Edition
This guidebook, now in its second edition, helps airport practitioners, owners, operators, managers, and policymakers of small airports with financial management, oversight of contracts and leases, safety and security, noise impacts, community relations, compliance with federal and state obligations, facility maintenance, and capital improvements. 2019; 364 pp.; TRB affiliates, $83.25; nonaffiliates, $111. Subscriber categories: administration and management, aviation.

Climate Resilience and Benefit–Cost Analysis: A Handbook for Airports
ACRP Research Report 199
This handbook provides process improvements for the evaluation of infrastructure investment strategies, with an emphasis on ensuring climate-related resiliency. Procedures for transparent presentations and implementation are also included. 2019; 164 pp.; TRB affiliates, $63.75; nonaffiliates, $85. Subscriber categories: aviation, economics, environment.

Comprehensive Bus Network Redesigns
TCRP Synthesis 140
Examined in this synthesis are the current states of practice in comprehensive bus network redesign among agencies of different sizes, geographical locations, and modes. 2019; 189 pp.; TRB affiliates, $68.25; nonaffiliates, $91. Subscriber categories: administration and management, planning and forecasting, public transportation.

Managing the Transit Scheduling Workforce
TCRP Synthesis 143
This synthesis examines how transit agencies are recruiting, training, developing, and retaining schedulers—including third parties—and analyzes how transit systems are adapting to industry and technological changes. Case examples are provided. 2019; 212 pp.; TRB affiliates, $69.75; nonaffiliates, $93. Subscriber categories: public transportation, administration and management, passenger transportation.

Airport Emergency Communications for People with Disabilities and Others with Access and Functional Needs
ACRP Research Report 201
Provided in this report are guidance and tools to aid airports in effective communication with passengers and persons with disabilities, including those with cultural and language differences. Templates, worksheets, and checklists for planning are included. 2019; 140 pp.; TRB affiliates, $60; nonaffiliates, $80. Subscriber categories: aviation, operations and traffic management, security and emergencies.

SAGE is now the publisher of the Transportation Research Record: Journal of the Transportation Research Board (TRR) series. To search for TRR articles, visit http://journals.sagepub.com/home/trr. To subscribe to the TRR, visit https://us.sagepub.com/en-us/nam/transportation-research-record/journal203503#subscribe.
## RECENT AND UPCOMING WEBINARS

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For more information, contact Elaine Ferrell, TRB, at 202-334-2399 or eferrell@nas.edu.

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## TRB STANDING COMMITTEES

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Additional information on TRB meetings, including calls for abstracts, meeting registration, and hotel reservations, is available at www.TRB.org/calendar, or by e-mail at TRBMeetings@nas.edu.

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*TRB is cosponsor of the meeting.
CONSENSUS AND ADVISORY STUDIES

September
25–26  U.S. Coast Guard Maritime Domain Awareness Study Committee Meeting
      Washington, D.C.
26–27  Long-Term Infrastructure Program (LTIP) Pavements Committee Meeting
      Washington, D.C.

October
13–16  Mobility Management Study Listening Session
      New York, New York
24–25  LTIP Bridges Committee Meeting
      Washington, D.C.

November
4–5    U.S. Coast Guard Maritime Domain Awareness Study Committee Meeting
      Washington, D.C.
6–7    Marine Board Fall 2019 Meeting
      Woods Hole, Massachusetts
18     FHWA Emerging Trends Symposium
      Washington, D.C.

December
10–11  Research and Technology Coordinating Committee Meeting
      Irvine, California

For more information on these events, e-mail Michael Covington, TRB, at mcovington@nas.edu.

COOPERATIVE RESEARCH PROGRAMS

The Behavioral Traffic Safety Cooperative Research Program will be releasing requests for proposals for its FY 2020 projects. For more information, see www.trb.org/BTSCP/BTSCRPProjects.aspx.

Problem statements are being accepted for the FY 2021 National Cooperative Highway Research Program. Problem statements will only be accepted from the following:

• State departments of transportation,
• AASHTO committees and councils, and
• Federal Highway Administration.

The deadline is Friday, Nov. 1, 2019. To download the template, visit http://onlinepubs.trb.org/onlinepubs/nchrp/docs/FY2021_Problem_Statement_Template.docx. For more information, see http://www.trb.org/NCHRPP/NCHRPP.aspx.

NASEM EVENTS

October
3    Space Technology Industry–Government–University Roundtable
      National Academy of Sciences Building, 2101 Constitution Ave.
      NW, Washington, D.C.
      For more information, contact Anesia Wilks at awilks@nas.edu or 202-334-1607.
7–8    Systems Approach to Reducing Consumer Food Waste Meeting
      Keck Center, 500 Fifth Street NW, Washington, D.C.
      For more information, contact Tina M. Latimer at TLatimer@nas.edu or 202-334-3218.
31–    Supplemental Treatment of Low-Activity Waste at the Hanford Nuclear Reservation
      Richland, Washington
      For more information, contact Darlene Gros at Hanford@nas.edu or 202-334-3066.

November
1    Computing, Communications, Cyber Resilience, and the Future of the U.S. Electric Power System
      Keck Center, 500 Fifth Street NW, Washington, D.C.
      For more information, contact Ben Wender at bwender@nas.edu or 202-334-3151.
21–22  Quality Water from Every Tap: A Workshop of the Environmental Health Matters Initiative
      National Academy of Sciences Building, 2101 Constitution Ave.
      NW, Washington, D.C.
      For more information, contact Marilee Shelton-Davenport at MShelton@nas.edu or 202-334-2155.
INFORMATION FOR CONTRIBUTORS TO TR NEWS

TR News welcomes the submission of articles for possible publication in the categories listed below. All articles submitted are subject to review by the Editorial Board and other reviewers to determine suitability for TR News; authors will be advised of acceptance of articles with or without revision. All articles accepted for publication are subject to editing for conciseness and appropriate language and style. Authors review and approve the edited version of the article before publication.

ARTICLES

FEATURES are timely articles of interest to transportation professionals, including administrators, planners, researchers, and practitioners in government, academia, and industry. Articles are encouraged on innovations and state-of-the-art practices pertaining to transportation research and development in all modes (highways and bridges, public transit, aviation, rail, marine, and others, such as pipelines, bicycles, pedestrians, etc.) and in all subject areas (planning and administration, design, materials and construction, facility maintenance, traffic control, safety, security, logistics, geology, law, environmental concerns, energy, technology, etc.). Manuscripts should be no longer than 3,000 words. Authors also should provide tables and graphics with corresponding captions (see Submission Requirements). Prospective authors are encouraged to submit a summary or outline of a proposed article for preliminary review.

MINIFEATURES are concise feature articles, typically 1,500 words in length. These can accompany feature articles as a supporting or related topic or can address a standalone topic.

SIDEBARS generally are embedded in a feature or minifeature article, going into additional detail on a topic addressed in the main article or highlighting important additional information related to that article. Sidebars are usually up to 750 words in length.

POINT OF VIEW is an occasional series of authored opinions on current transportation issues. Articles (1,000 to 2,000 words) may be submitted with appropriate, high-quality graphics, and are subject to review and editing.

RESEARCH PAYS OFF highlights research projects, studies, demonstrations, and improved methods or processes that provide innovative, cost-effective solutions to important transportation-related problems in all modes. Research Pays Off articles should describe cases in which the application of project findings has resulted in benefits to transportation agencies or to the public, or in which substantial benefits are expected. Articles (approximately 750 to 1,000 words) should delineate the problem, research, and benefits, and be accompanied by the logo of the agency or organization submitting the article, as well a one or two photos or graphics. Research Pays Off topics must be approved by the RPO Task Force; to submit a topic for consideration, contact Stephen Maher at 202-334-2955 or smaher@nas.edu.

OTHER CONTENT

TRB HIGHLIGHTS are short (500- to 750-word) articles about TRB-specific news, initiatives, deliverables, or projects. Cooperative Research Programs project announcements and write-ups are welcomed, as are news from other divisions of the National Academies of Sciences, Engineering, and Medicine.

BOOKSHELF announces publications in the transportation field. Abstracts (100 to 200 words) should include title, author, publisher, address at which publication may be obtained, number of pages, price, Web link, and DOI or ISBN. Publishers are invited to submit copies of new publications for announcement (see contact information below).

SUBMISSION REQUIREMENTS:

› Articles submitted for possible publication in TR News and any correspondence on editorial matters should be sent to the TR News Editor, Transportation Research Board, 500 Fifth Street, NW, Washington, DC 20001, 202-334-2986, or lcamarda@nas.edu.

› Submit graphic elements—photos, illustrations, tables, and figures—to complement the text. Images must be submitted as TIFF or JPEG files and must be at least 3 in. by 5 in. with a resolution of 300 dpi. Large photos (8 in. by 11 in. at 300 dpi) are welcomed for possible use as magazine cover images. A caption must be supplied for each graphic element.

Note: Authors are responsible for the authenticity of their articles and for obtaining written permissions from publishers or persons who own the copyright to any previously published or copyrighted material used in the articles as well as any copyrighted images submitted as graphics.
Join more than 13,000 transportation professionals at the TRB Annual Meeting, January 12–16, 2020, in Washington, D.C.

The program will cover all transportation modes, with more than 5,000 presentations in nearly 800 sessions, addressing topics of interest to policy makers, researchers, administrators, practitioners, and representatives of government, industry, and academic institutions.

Also, a number of sessions and workshops will focus on the spotlight theme for the 2020 meeting, “A Century of Progress: Foundation for the Future.”

The full 2020 program will be available online in November, 2019.

Plan now to attend. For more information, visit www.trb.org/AnnualMeeting.