TR NEWS
January–February 2020 NUMBER 325

Aviation Logistics at Burning Man Festival

PLUS

Data for Transportation Decisions: Findings from the States

Rural Public Transportation

50 Years of NEPA

100 YEARS MOVING IDEAS: ADVANCING SOCIETY

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* Membership as of February 2020.

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COVER Burning Man Festival encampment, as viewed from an airplane—the mode of arrival for many of the festival's attendees, and one of the topics of this issue of *TR News*. (Photo: Alaska DOT)

Coming Next Issue

A record-setting crowd of nearly 14,000 attendees gathered at the TRB 99th Annual Meeting, January 12–16, 2020, in Washington, D.C. The March–April 2020 *TR News* features photo highlights from the Annual Meeting.

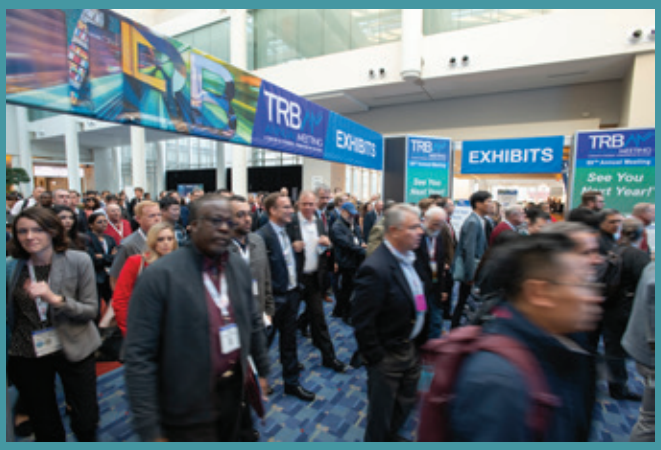

Photo: Risdon Photography

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.

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DATA'S CRITICAL ROLE IN TRANSPORTATION DECISIONS

Findings from the Transportation Research Board's 2019 State Partnership Visits Program

Photo: Chris Hedges, TRB

The Technical Activities Division of the Transportation Research Board (TRB) conducts the State Partnership Visits Program, in which TRB staff with expertise in various modes and topics visit state departments of transportation (DOTs), university transportation centers, transit and other modal agencies, and private industry. These visits support TRB's mission of promoting innovation and progress in transportation through research and information exchange by identifying needed research and research in progress and by disseminating completed research results.

One of the most time-honored of the technical activities that TRB performs, state visits last one or two days and typically consist of meetings with various levels of DOT management; discussions with DOT staff involved in various topic areas; exchanges of issues and ideas; and, often, a visit to DOT facilities or to project sites. Technical Activities Division staff members contributed to the following summary of the issues facing state DOTs, revealed through the state visits program in 2019.

Above: The TRB State Partnership Visits offer a snapshot both of current issues facing state DOTs and of emerging transportation trends.

Planning

The planning community continues to retool their agency methods and decision-making processes to be informed by data based on analytics and multimodal system performance. The theme of data-informed decision-making was reflected in two specialty conferences that were coordinated by different planning committees. The Standing Committee on Transportation Planning Applications held its biannual AppCon conference in Portland, Oregon, in June. The conference included interactive sessions and workshops on the application of specific technical tools and methods that could be used in DOT decision-making.

The Section on Transportation Policy, Planning, and Processes sponsored the Conference on Performance and Data in Transportation Decision-Making in Atlanta, Georgia, in September to share policy and technical approaches to creating a more data-informed planning process. The conference drew more than 300 executives and professionals from state DOTs, metropolitan planning agencies, transit agencies, professional associations, and the private sector to share experiences and lessons learned from the application of data and analytics to planning. A Transportation Research E-Circular in development will report on the discussions that took place at the conference.

As "big data" become ubiquitous, it is anticipated that planning discussions will continue to use analytics to inform their processes and tackle the rapidly changing transportation industry, including how to integrate new modes, services, and technologies into transportation infrastructure and service portfolios.

Data

State DOTs report the increasing importance of data and information to support

their operations and decision-making, especially in an era of rapid change. For state agencies, this approach involves quicker response time and better analysis of data, often blended from multiple sources. The governor of Iowa has assigned lead agency responsibilities in data analytics to the state DOT, which is developing a strategic data business plan.

The recognition of the critical role of freight transportation in state economies is becoming widespread. Technology that offers the ability to track trucks by characteristics is growing quickly, but decision-makers also are increasing investment in projects that provide better ways of determining "what is in the box." This information helps agencies demonstrate the value of freight transportation to the economy.

Research

In recent years, TRB has participated in several research-focused peer exchanges. As they identify and prioritize research needs, state DOT research offices also seek to share information on the design and management of research programs, contracts, and requests for proposals. Agencies face challenges in documenting the results of research, including identifying appropriate performance measures, tracking implementation, calculating return on investment, and finding outcomes. State DOTs have identified a need for improved communication mechanisms among research offices to minimize the duplication of research efforts. This includes exploring such research deliverables as short videos, quick summaries, and webinars to disseminate research findings in a more digestible way.

States also are considering the potential impacts of technology—especially automation—on the transportation workforce. One state agency cited recruiting and retaining new employees—in particular, midcareer engineers—as a major concern, along with competition for employees of protected classes.

Aviation

The rising use of automated technologies in aviation by state agencies continues to be managed and monitored. Some state aviation departments are helping develop initiatives to use drone technologies in other DOT business practices, including traffic incident management, structural and right-of-way inspections, construction project management, and environmental surveys. Using these technologies appropriately and effectively requires coordination within the regulatory framework that is still being developed at the federal, state, and local levels. Therefore, states are working with their regulatory counterparts to more effectively monitor, track, and prevent inappropriate use of drones—particularly near airports, where drones may pose a safety threat to aircraft operations, and near people and high population centers.

Photo: Washington State DOT

Washington State DOT employees assess rockslide damage using drones. Drone technology is helping agencies with traffic incident management, inspections, project management, and environmental surveys.

Freight

Several innovations and trends are driving freight mobility toward automation and autonomous strategies that leverage big data. Pervasive e-commerce demands, data-optimized supply chain logistics, warehousing and distribution advances, and shortages in human capital top the list of issues.

Recognizing the economic impacts and potential efficiencies for highway systems, the Federal Motor Carrier Safety Administration is working on rules to reduce barriers and set up regulatory frameworks to facilitate the safe introduction of automated driving systems–equipped commercial motor vehicles. For example, in December 2019, a truck drove 2,800 miles of the Interstate system from California to Pennsylvania—operating mostly in autonomous mode—to deliver a full truckload of refrigerated goods for Land O'Lakes.

Ports and Waterways

Trends in automation and digitalization within the freight system once again dominated research, business forums, and regulatory discussions in 2019. In the seaport industry, ever-increasing vessel sizes and the resulting landside cargo surges from megaship calls are driving operators at many congested U.S. seaports to adopt automation to achieve more efficient cargo handling.

The Port of Virginia is one of several terminals using automated container handling systems, allowing for better scheduling and longer operating hours.

At ports in California, Virginia, and New Jersey, automated container handling systems allow terminals to condense operations onto limited footprints. These systems optimize terminals to synchronize better with rail schedules and truck gate appointment systems and allow for longer terminal operating hours, spreading the peak at the gate and decreasing individual truck turn times.

On the inland waterways system, the U.S. Army Corps of Engineers is involved in an international working group, via the World Association for Waterborne Transport Infrastructure, that assesses standards, guidelines, and best practices for automation and remote operation of locks and bridges.

Rail

Rail-related fatalities occur among members of the public far more than among railroad passengers or employees. These fatalities include those involved in highway–rail grade crossing crashes; pedestrian strikes, often of trespassers; and suicides.

Photo: Virginia DOT

An example of the dynamic envelope at a highway–rail grade crossing in Florida.

Photo: Florida DOT

Recent state DOT efforts have concentrated on safety measures in these areas.

Florida recently noted increases in rail traffic because of increased commuter and intercity rail service and a continuing high level of freight traffic. Grade crossing and pedestrian–trespasser fatalities have increased to the point that they now are a major public safety concern. Florida DOT is implementing an engineering countermeasure, called "dynamic envelopes," at highway–rail grade crossings. These consist of pavement markings that delineate the areas around a rail crossing within which a vehicle or pedestrian would be in danger of being struck. Other initiatives include increased enforcement of traffic laws at crossings and targeted countermeasures in areas that experience frequent pedestrian trespassing.

One recent development that has caught the attention of state DOTs is the concept, adopted by many rail carriers, of precision-scheduled railroading (PSR). This concept involves strict schedule adherence, concentration of assets, and labor reduction, resulting in longer and heavier trains. In many cases, PSR has led to longer highway–rail crossing blockages and disruptions to manufacturing supply chains. The motoring public and manufacturing and logistics industries have turned to state DOTs for assistance in alleviating these problems, and state DOTs struggle with how to assist their constituents with these issues.

Public Transportation

In summer 2019, TRB participated in the Idaho Public Transportation Summit. The rural public transportation issues addressed included mobility options in rural communities, nonemergency medical transportation, intercity bus services, and route deviation. One transit agency entered an agreement with a transportation network company (TNC) to extend its service coverage. More than 80 buses serve employees of the Idaho National Laboratory. TRB staff reported on TRB's work of interest, such as the Rural Transportation Issues Research Roadmap, the National Intercity Bus Atlas, and conferences on rural public and intercity bus transportation and demand-responsive transportation.

The industry continues to experiment with innovative service delivery options and technologies; for example, exploring opportunities to use TNCs in the provision of paratransit services in accordance

Photo: Rabenspiegal, Pixabay

Transit agencies are considering how to navigate practical and policy issues associated with rising e-scooter use.

with the Americans with Disabilities Act of 1990. Transit agencies also are considering how to harness e-scooters, a new option for shared micromobility and first–last mile connection. Mobility as a Service, or MaaS, is becoming more popular, with transit agencies reflecting on their possible roles as leaders or bridges between public and private transportation providers.

Environment, Energy, and Climate Change

Near-road air quality issues were the subject of a transportation pooled fund study, which helped states identify and address a broad range of issues, from meeting U.S. Environmental Protection Agency–mandated near-road monitoring to modeling for carbon monoxide and particulate matter hot spots.

States also are collaborating to identify best practices on historic bridge rehabilitation, creative mitigation strategies in the public involvement process and Section 106 of the National Environmental Policy Act, and ways to accomplish the requirements of the One Federal Decision Executive Order of 2017. Emerging issues for states include remediation requirements of per- and polyflouroalkyl substances and other organic contaminants and the environment and energy implications of the growing number of shared, automated, and electrified transportation options.

Equity

Accessible and affordable transportation options are crucial for people to access better jobs, secure educational opportunities, buy food and other daily provisions, and receive essential health services. In certain conditions, infrastructure, technologies, and policies unintentionally leave underserved populations without access to affordable transportation options. Transit Cooperative Research Program Project B-47, "Impacts of Transformational Technologies on Underserved Populations," is developing a playbook with guidance on corrective action for transit agencies regarding data, methods, and metrics to achieve inclusive mobility in an era of transformational technologies.

Minnesota DOT is commencing a transportation equity initiative to better understand how the transportation system, services, and decision-making processes help or hinder the lives of people in the state's underserved and underrepresented communities. The initiative also will identify possible solutions to address challenges and develop partnerships to advance transportation equity in Minnesota.

Photo: nyttend, Wikimedia

The Carrollton Bridge in Indiana, built in 1927, was rehabilitated nearly a century later. Historic bridge rehabilitation—conducted with the environment in mind—is an emerging issue for states.

Legal

Transportation attorneys are placing an increasing focus on how the actual and forecast impacts of the changing climate, along with the effects of recent disaster events on transportation facilities across the country, pose resiliency considerations in project development and asset management planning, as well as on the corresponding litigation risks.

The concept of Complete Streets, embraced by the 2018 edition of American Association of State Highway and Transportation Officials' *Policy on Geometric Design of Highways and Streets,* encompasses many approaches to the design and operation of roadways and rights-of-way, with a focus on making the transportation network safer and more efficient for all users. Public agency lawyers are looking closely at attendant tort liability and risk management considerations and best practices for factoring them into their clients' transportation design needs.

Risk allocation and mitigation is an ever-present factor in projects of all types and sizes—but more so in alternative delivery projects, such as those using design–build methods and public–private partnerships. Lawyers representing owner agencies are more and more involved with identifying the risk-assessment life cycle and management: the identification and allocation of risks at a project's early stages; contractual considerations for the owner's desired risk-sharing mechanisms; a risk profile's effect on funding, price, and contingencies; and enforcement of the contract.

The growing popularity of such innovations as ridesharing, microtransit, dockless micromobility, and automated vehicles poses many challenges and opportunities for public transportation systems across the country. Among these challenges are legal and regulatory issues, including funding and litigation risks.

Highway Design

More and more, resilient and sustainable pavement designs are topics of research and of practical application as changes in weather patterns cause shifts in temperature and precipitation that affect pavement performance, life, and economics.

Photo: hydropeek, Flickr

The deck of the Pulaski Skyway Bridge in New Jersey used 5,000 cubic yards of ultrahigh-performance concrete.

Increased occurrences of flooding and temperature extremes affect pavements adversely. Also of concern is the heat reflected from pavements, especially in urban environments. Pavement life-cycle cost analysis is a topic of extensive study to help assess the breadth of the problem and better manage it in the future.

Many state DOTs use ultrahigh-performance concrete (UHPC) in bridges and structures. After a marked increase in UHPC use over the past several years, it is estimated that nearly 300 bridges nationwide use the material in superstructures, substructures, or both. Advantages of UHPC include lighter-weight bridge designs, decreased construction times when using precast system elements, increased durability and corrosion resistance of bridge members, extended service life, and reduced bridge maintenance and rehabilitation (which, incidentally, can increase worker safety in the long run).

States also have used UHPC in precast systems and for bridge decks, closure pours, and connections among precast members. For example, the Pulaski Skyway Bridge rehabilitation in northern New Jersey used a total of 5,000 cubic yards of UHPC in its bridge deck. Other states also have seen favorable results with UHPC.

Highway Construction and Materials

Ohio and Illinois are pursuing construction methods to increase pavement durability and longevity by targeting higher density at pavement joints. Core sampling and other procedures have been added to quality assurance plans at or near the joints, instead of just on the mat, to draw attention to this critical location at which damage is more likely to occur. Also used in paving trials are joint-sealing materials that decrease permeable infiltration of water to one side of a joint before the neighboring lane is paved.

Ohio also has explored the use of nondestructive rolling density meters, as walk-behind ground-penetrating radar units, for faster assessment and wider coverage than cores at spot locations. Several bridge construction projects in Oregon have placed new decks using concrete mixtures designed with special aggregate blends and mix designs that promote internal curing with better cement hydration, which can lead to fewer cracks.

South Carolina is bundling multiple bridge replacement projects together, using the design–build method of project delivery, to reduce risk and promote efficient construction, thus saving time and money.

Geotechnical Engineering

Monitoring the moisture–temperature profile in soils with depth provides soil temperature, moisture, and suction data. When paired with weather and soil properties, these data can feed into computational models as predictive tools. Such models are especially important for states in cold regions that manage lower-volume roads susceptible to subgrade weakening and seasonal traffic-induced damage. Properly predicting the timing and duration of the thaw and related soil weakening, and then posting seasonal road restrictions, can help minimize or eliminate damage to the road as well as the impact on local and regional populations and economies. Iowa, Minnesota, Alaska, and North Dakota are some of the states developing, refining, and using such tools.

Photo: Groveland Media, Flickr

Several states, including Minnesota, are developing, refining, and using tools that minimize the impact of freeze–thaw cycles on roadways.

Whether as routine maintenance or because of an emergency triggered by a catastrophic event, the stability of rock and soil slopes continues to be a focus for geotechnical researchers and practitioners at many state transportation agencies. Tennessee DOT has identified slopes as their second-most critical asset. Many states—including Vermont, Washington, and Montana—have a proactive slope rating and management system. Alaska DOT is developing a corridor health index, which includes consideration for "threatening slopes," to aid in budget decisions. These advance concepts and technologies have allowed states to take a more preventative approach; for example, Oregon DOT uses lidar and remote-sensing instruments to examine slope deformation and changes.

The high-tech world of 3-D visualization and gaming technology has reached the geotechnical community. To review the options for a new road alignment, California transportation professionals donned goggles to view subsurface boring data, land surface topography, and aerial images combined with virtual and augmented reality tools. Seeing a 3-D layout and being able to move around virtually within the subsurface and surface features helped these transportation officials making better-informed decisions.

Highway Maintenance and Preservation

Across the nation, maintenance divisions at public agencies face workforce staffing challenges. Several agencies cannot compete with salary levels in the private sector. The workforce and retention issue is not limited to maintenance departments, but neither are the possible solutions. Georgia DOT has deployed a program, used initially within its Division of Planning, in which contract staff are initially hired as temporary workers to see they are a good fit. The DOT then could offer workers full-time positions, which provide benefits and higher pay. Other agencies have explored state maintenance innovation programs to incentivize creativity in maintenance field offices and to create a desirable place to work.

Highway maintenance departments also are experimenting with the practical application of artificial intelligence and machine learning to help forecast maintenance rehabilitation costs, supplement bridge and pavement management systems, and provide a prediction of winter weather roadway surface conditions. These tools are just starting see application beyond the initial experimental stages. The amount of data is expected to increase further, and these tools will help agencies and maintenance departments transform data into useful information.

Highway Operations

A decade ago, an innovative concept for interchange design and operations—the diverging diamond interchange (DDI)—was first constructed in Missouri. A DDI facilitates free-flowing turns by temporarily crossing the traffic to the left side of the roadway, thus eliminating the left turn against oncoming traffic and limiting the number of traffic signal phases. Today, this innovative design is a widely accepted alternative to interchanges. When compared to conventional diamond interchange designs, the DDI design increases throughput and reduces delay and has been found to be significantly safer than conventional diamond signalized interchanges. More than 100 DDIs are now in operation around the country, with more than 30 under construction and more than 150 under study.

In the United States, wrong-way driving (WWD) crashes result in 300 to 400 fatalities each year. Although WWD crashes are random and infrequent, they typically involve high-speed head-on or sideswipe crashes that result in multiple injuries or fatalities. Many states now are exploring programs to try to reduce these crashes, such as improved traffic control devices, warning systems for wrong-way-entering drivers, and alerts for transportation management centers and first responders.

The development of connected and automated vehicles (CAVs) continues to dominate operations research and capture the attention of DOTs across the country. Since 2012, more than 40 states and the District of Columbia have enacted or are considering legislation related to automated vehicles. Auto manufacturers, suppliers, technology companies, and state DOTs constantly announce new testing and deployment. The future impacts of CAV on transportation are wide-ranging and will be felt in the areas of transportation operations, safety, pavements, transit, and freight movements.

Photo: Coolcaesar, Wikimedia

Wrong-way driving crashes result in nearly 400 fatalities each year. Solutions deployed by states include traffic control devices like signage and warning systems.

Did You Know?

- Pipeline transportation accounts for 19% of total U.S. freight ton-miles.
- In 2017, U.S. consumption of gasoline, diesel, and other fuels for highway use was almost 178 billion gallons.
- Average hydrocarbon emissions (grams/mile) for gasoline-powered automobiles in the United States has dropped from 1.32 in 2000 to 0.28 in 2018.
- Anchorage, Alaska, has the second-busiest U.S. cargo airport (by landed weight of all-cargo shipments). First- and third-busiest, respectively, are Memphis, Tennessee, and Louisville, Kentucky.
- Passenger cars and light trucks accounted for 91.5% of U.S. vehicle miles traveled in 2017.
- The transportation and utilities industry employs 5.5% of all U.S. employees.
- California has the most highway tunnels (90) of any state. Ten states have none.
- In California, the ports of Los Angeles and Long Beach have more than 150 container cranes combined.

Photo: Lan Bui, Flickr

The Port of Long Beach, when combined with the Port of Los Angeles, has more than 150 container cranes.

- New York has the most transit trips of any state. Second is California, with more than twice the number of transit trips as the third-highest state, Illinois.
- The average freight shipment by truck travels 188 miles. The average freight shipment by rail travels 554 miles. The average freight shipment by combined rail and truck travels 1,140 miles.

Safety

According to the National Highway Traffic Safety Administration, 36,560 people were killed in motor vehicle crashes on the nation's roadways in 2018. This marks a decrease of 2.4% from 2017, which followed a 0.9% decrease from 2016 and back-to-back yearly increases in 2015 and 2016. Nationwide vehicle miles traveled seem to have increased by 0.3% from 2017 to 2018.

The number of crash fatalities remains unacceptably high, however, and has not yet returned to the lower levels experienced between 2010 and 2014. In 2018, decreases in fatalities occurred in almost all segments of the population—with the exception of fatal crashes involving large trucks, pedestrians, and pedalcyclists.

To strengthen motor vehicle crash reduction efforts, Connecticut DOT collaborated with the University of Connecticut Transportation Safety Research Center (CTSRC) to develop the Connecticut Crash Data Repository. As a result, crash report processing times have been reduced from 16 months to two weeks. Crash data also is linked with roadway, judicial, and public health data from other state sources, which further strengthens safety decision-making. The repository earned Connecticut DOT and CTSRC a special achievement award from the Governors Highway Safety Association.

The Kentucky Transportation Cabinet (KYTC) also uses data to better inform investment decisions. KYTC's Strategic Highway Investment Formula for Tomorrow is a data-driven, objective approach to comparing capital improvement projects. Safety is one of five attributes scored to help prioritize limited transportation funds, along with asset management, congestion, economic growth, and cost–benefit. KYTC currently is updating its Strategic Highway Safety Plan as a data-driven approach to reducing crash-related fatalities and serious injuries across the state. In partnership with the University of Kentucky, the Safety Circuit Rider program uses crash data to locate high-incident sites along roadways and to assist communities in finding low-cost roadway safety improvements.

Conclusion

The 2019 State Partnership Visits Program offered TRB staff and state DOT personnel many opportunities to meet and discuss the most pressing transportation issues facing the nation and the many policies and programs that state DOTs are using to improve the transportation system in order to make it more safe, efficient, and resilient. Information exchanges on current and needed research topics informed all parties of the latest advances in technology and methodologies.

Photo: Kevin Dooley

Meeting the Transportation Needs of Rural Communities

Lessons That Cannot Be Learned from Urban Transit

PETER SCHAUER

The author is Principal, Peter Schauer Associates, Boonville, Missouri. He is emeritus member of the TRB Rural Public and Intercity Bus Transportation Committee.

Rural transit did not become part of the social milieu of the United States until 1964, when President Lyndon B. Johnson's War on Poverty produced an array of new federally supported services. Rural transit has a short history—about 50 years—but urban transit and its planning have been around for much longer. The Industrial Revolution in the 18th and 19th centuries meant that people no longer worked at home and needed a way to travel to factories, which urban transit provided (*1–2*). When in the 20th century mass-produced automobiles became the preferred mode of travel and employers and employees moved to the suburbs, however, the transit industry started to lose its share of the market and did little in response to attract new passengers or keep old ones. Transit rapidly became the conveyance for those who had no other choice (*3*).

Rural transit then burst onto the transportation scene, new and somewhat

Photo: Philly History.org

The Industrial Revolution of the 18th and 19th centuries created a need for urban transit, as people sought ways to travel to factories for work.

Above: Federal services introduced by Johnson's War on Poverty in the mid-1960s ushered in new attention to rural transit.

amorphous (Figure 1, below). It was the result of a combination of factors—some shared with urban areas, such as the dominance of the automobile as a mode of travel, and some unique, such as the need to support travel over long distances to services and trades. Unlike urban transit, rural transit has no prescribed federal planning requirements for a transit development plan; that is, a wide range of activities and service types can emerge to fit the multitude of unique conditions found in rural America. Even the term "rural" has various meanings: for some, it may mean the lack of population density; for others, it may mean distance to a metropolitan area or total population of a given geographic area.

The accepted definition of "rural" used in the field of rural passenger transportation in the United States—and used by the U.S. Department of Transportation (DOT) to administer Section 5311 Rural Area Formula Program Grants—is any area that is not urbanized; that is, any area that does not have a population of 50,000 or more.

Rural Transit Is Not Miniature Urban Transit

Rural transit is not miniature or scaled-down urban transit. The term "rural transit" refers to a service available to the public in a vehicle of varying types and dimensions. The vehicle generally is rubber-tired or waterborne. By comparison, urban transit can have these same attributes, but also can include light rail, heavy commuter rail, trolleys, and more.

To think of rural transit as miniature urban transit unfairly characterizes the differences between rural and urban communities and their transportation needs. Early rural transit advocates perceived a degree of unfairness and felt the amount of funding rural transit was receiving in comparison with urban areas was not equitable. They believed that it was not fair for rural transit to receive no federal funding support when urban transit was receiving federal support.

In 1977, before the Surface Transportation Act of 1978 was enacted—the most significant legislation supporting rural transit—the Rural America Organization stated that although 60% of low-income need was found in rural areas, only 6% of federal outlays for public transportation in fiscal year (FY) 1976 was allocated to rural areas (*4*).

Photo: Peter Schauer

The first annual Missouri Transportation Workshop, sponsored by OATS, took place in September 1975 at Camp Cloverpoint in Kaiser, Missouri.

The inequity of the distribution of funds was a rallying point for a growing number of rural transit providers and social service advocates in the late 1960s and early 1970s. These groups emphasized the need for rural passenger transportation, which became evident in the early 1970s as a result of the social services established by the Older Americans Act of 1965 (OAA) and by the Economic Opportunity Act of 1964 (EOA). These two pieces of legislation established state units on aging and local Area Agencies on Aging (AAAs) and authorized the formation of local Community Action Agencies (CAAs), respectively, as part of the War on Poverty.

AAA units established senior gathering places (senior centers), which included nutrition sites for dining and other health and recreation programs for senior citizens. Similarly, CAAs established a wide range of social services—including job training, youth development, energy assistance and home weatherization, and more—to eliminate poverty and its root causes. According to the Connecticut Association for Community Action website, "the Community Action Program would serve the role of helping members of the community access the services they needed on the community level, with the ultimate goal of guiding the people benefiting from the services to independence and sustainability" (*6*).

Central to both OAA and EOA was the independence and sustainability of the people they were intended to serve. OAA enhanced the independence and sustainability of older people to live in their own homes and EOA enhanced the independence and sustainability of low-income people. Both CAAs and AAAs quickly recognized that independence and sustainability could not be achieved without accessibility to services, and they set about

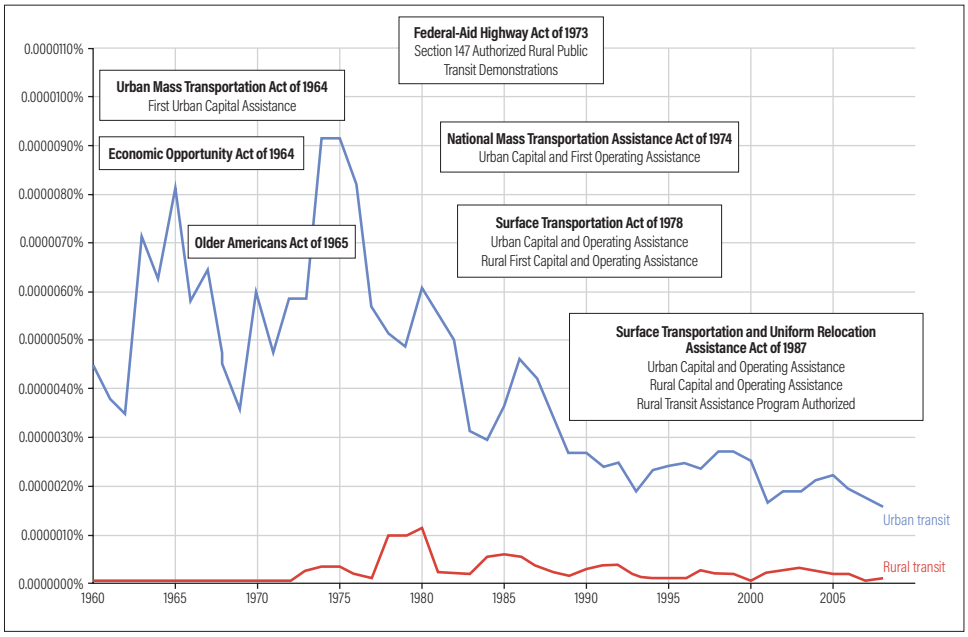

FIGURE 1 Significant milestones in rural transit (*red*) and urban transit (*blue*) and their relative term mention in books, 1960–2008 (*5*).
Note: Highway Research Board was renamed the Transportation Research Board in 1974.

Photo: Knox County Government

Rural transit programs enable seniors in Knox County, Tennessee, to live more independently and to pursue interests.

establishing formal and ad hoc transit programs for the people who needed their services. The number of rural services of all types grew exponentially (*7*).

A variety of service types were implemented, even voucher-type services that used private taxis. Some services had purpose-built vehicles with specialized wheelchair lifts, and others simply provided services with government surplus military buses.[1] CAAs and AAAs both made accessibility a high priority; the ultimate goal of their transportation efforts was ensuring that all their services were accessible.

Planning and Understanding Demand

How much transportation can allow a rural person to have an independent and sustainable life? Even after approximately 40 years of federal involvement in rural public transit—and 50 years of federal involvement in urban transit—it has not been rigorously established what exactly constitutes sufficiency in mobility or accessibility in order for transportation users to maintain a minimum standard of living (*8*). Thus, rural transit struggles to make the case for public financial support based on conventional transportation planning programs, as the strict focus on maximizing the mobility of people and goods does not work.

With no federally mandated planning practices for early rural transit development, advocates instead argued that plans should be based on people's need to access social and medical services in order to have sustainable and independent lives. Simply making sure that people and goods can move does not translate into accessibility of needed services and goods. Conventional mobility planning has resulted in a transportation system that primarily supports private automobile travel—but how does this serve those without access to a car?

What would it mean, then, to refocus transportation planning on accessibility rather than simply on mobility? Without set standards, this would be difficult. Even the most obvious service standards (for example, seven-day-a-week transit service that offers an alternative to an automobile and allows a person to live a sustainable and independent life) are extremely rare in rural settings—and even in urban settings, for that matter.

Without measureable standards such as those for highways, it is difficult to define rural public transit as a utility versus a social service. The utility-versus-social-service argument about transit perhaps allows urban transit to be called a utility, based on its necessity for commerce, labor movement, and the environment. Rural public transit functions more as a social service, and the funding mechanisms described below further bolster this conclusion.

Discovery Through Demonstrations

For advocates and state DOT officials in the early 70's, it became clear that rural public transit required a different approach to planning and implementation of services. Transportation planners would have to respond in new and different ways, particularly when planning for persons who are elderly or disabled, of whom there are proportionately more in rural than in urban areas (*9*).

When CAAs and AAAs developed early transportation services, these agencies were not quantitatively or logistically sophisticated. Their programs needed participants and participants needed the programs but could not access them, so CAAs and AAAs initiated passenger transportation services to support their

Photo: David Wilson, Flickr

Missouri's OATS Transit provides deviated-fixed routes and medical, senior, toddler, preschool, and general rural transportation to 97 counties in the state—making it the largest and most unique system of its kind in the country.

[1] Highlights of the development of AAAs and CAPs—creative, innovative programs that ranged from West Virginia's TRIP program, modeled after food stamps, to a wide range of paratransit services—are presented in the history of TRB Rural Committee. For more, see Schauer (*10*).

general mission of independence and sustainability. Since many people could not sustain their lives independently without transportation, the agencies provided whatever passenger transportation their budgets would allow, rather than conducting a thorough analysis of community needs. Eventually, more-sophisticated and more-frequent analysis was performed as more federal funds became available and as some states began to require planning procedures, but these analyses were not necessarily more precise in their approaches to quantify need or demand.[2]

Because of this, early practitioners of rural public transit or rural specialized passenger transportation typically used two traditional methods of planning and implementing services: demonstrations and peer group comparisons. The most successful of the demonstration approach is Missouri's OATS program (previously the Older Adults Transportation Service, now formally titled Operating Above the Standard), the largest rural public transit system in the United States.

In the early 1970s, the Missouri state unit on aging reportedly offered funds to a group of senior citizen advocates to study the problems of older adult transportation in Missouri, but the advocates instead pursued a demonstration grant of $30,259 for the actual operation of a small bus service. The August 9, 1971, minutes of the OATS founding committee documents the discussion of the founders, in which they concluded: "We will be a demonstration project and if we can show a need for this program and it is a success we can then expand to other counties and ask for a larger grant." From that small beginning—with three 15-passenger maxi-vans operating in four counties—OATS eventually grew to its current size: 800 vehicles and 700 employees providing services in 87 counties, with an operating budget of $28,992,420 (*9*). The need for OATS has been demonstrated.

[2] For more on problems of predicting need or demand for rural public transit, see Schauer (*10*). For more on problems of predicting need and demand for persons with disabilities, see Rosenbloom (*7*).

TABLE 1 Percent of Total Operating Budget for Rural Public Transit (*10–11*)

FUNDING SOURCE	1985 (%)	2015 (%)	TREND
Federal	26.5	34.0	↑
State	11.0	19.0	↑
Local	43.7	26.0	↓
Fares	27.8[a]	9.0	NA
Contracts	NA[a]	10.0	NA

[a] Data for contracts and composition of fares in 1985 are not available. It is likely that fares included contract revenues.

Validating need and demand through demonstrations was formalized through the Federal Aid Highway Act of 1973 Section 147, the Rural Highway Public Transportation Demonstration Program. This was the first federally funded initiative for rural transit to recognize the transportation needs of rural America as a legitimate part of the nation's emerging transportation policy. In 1974, funds were appropriated and by 1979, 134 projects were awarded—at least one in every state. Some of those projects continue to this day, but more than a few were discontinued or consolidated into larger efforts as rural public transit funding became available through the Surface Transportation Assistance Act of 1978, which included a funding source specifically for rural public transit in its Section 18.

By this time, a wide variety of services had dedicated funding sources, so transit advocates began asking questions to evaluate these services to get a better sense of the need, demand, and operational costs for services. These all became pertinent questions, especially for state officials who were concerned about substituting U.S. DOT Section 18 funds for previously dedicated U.S. Department of Health and Human Services social service funds provided by AAAs, CAAs, and similar organizations.

Although the data are not conclusive, the trend has been toward increased federal and state support of rural transit as a percentage of operating costs and a reduced percentage from local sources. Of course, the amount and total operating costs of services have increased since 1978, but in general, federal and state dollars for rural transit have increased both in aggregate and as a percentage of operating costs (see Table 1, above).

Despite those concerns, states supported the concept of rural public transit but were somewhat stunned to find that they were having difficulties obligating all their new Section 18 funds. Upon examination, it turned out that this was due to the requirement that operating grants be matched 50% with local funds. For example, a $100,000 project with a grant request for $50,000 in Section 18 operating funds had to be matched with $50,000 in local unrestricted funds. For many potential rural transit projects, it was impossible to secure 50% hard-cash, local funds for a match.

Local Match Redefined

The redefinition of "local match" was a boon for rural transit. This began in the state of Texas, which had obligated only 35% of its FY 1980 funds as of May 31, 1983 (*12*). Transit advocates and service providers in Texas were understandably concerned until Austin-based transit consultant Peter Canga devised a solution to the local match problem that ultimately changed the nature of rural transit. Canga understood both the heritage of rural transit as a social service and the workings of federal grant programs; through creativity and persistence, he was able to secure a memo from the Federal Highway Administration dated August 1982, which stated: "funds obtained by a Sec. 18 operator through purchase of service contracts with a human service agency may be used for local match without any restrictions" (*12*). The implementation of this new matching procedure required a 1985 amendment to

Public Transit in Native American Communities

Early Beginnings and Progress

The Johnson administration provided additional social service funding to American Indian tribes and reservations and, in 1968, called for an end to previously active tribal termination programs (*1*). As a result of Johnson's War on Poverty, tribes started providing transportation to specific social services in the 1960s.

In addition to the growth of social services and the accompanying need to transport people to those programs, the emergence and growth of tribal rural public transportation also was heavily influenced by public transit demonstrations. In 1975, as part of the Federal Highway Administration's Section 147 demonstration program, 11 demonstrations were conducted for tribal organizations within Indian reservations and communities (*2*).

Although seven of the 11 Section 147 projects ended when the demonstrations terminated in 1979, many stakeholders hoped the others would find continued funding through the newly available Section 18 of the Surface Transportation Assistance Act of 1978 (*3*). Some expressed concern that, because Section 18 was allocated by formula to states and there was a "history of bad relationships between the Tribe and the state," tribes would not receive a fair and equitable distribution: "state pass-through funding is also a departure from the historical practice in which the sovereign Indian tribes always maintained a unique and direct relationship with the Federal government" (*3*).

In the face of these concerns, the Menominee Indian Tribe of Wisconsin, through a feasibility study provided by the Wisconsin Department of Transportation in 1980, implemented a coordinated Section 18 program. Menominee Regional Public Transit (MRPT) "represents a synergistic partnership of agencies on and off the reservation" that enabled the service to provide transit to Indians and non-Indians (*4*). Today, MRPT is one of the largest and most successful public transit services of any type in the United States.

Most tribes did not access Section 18 funds because local matching funds were lacking and because of other concerns about signing required federal certifications and assurances, particularly transit labor protection certification 13(C). In 1999, the Urban Mass Transportation Act that, interestingly, did not apply to urban transit grants (*10*).

Origins of the Rural Transit Assistance Program

RURAL TRANSPORTATION INFORMATION

Although they were not subject to project-intensive federal planning requirements, rural transit providers still wanted to implement best practices and interact with other practitioners. They lacked a widely recognized single source of information, however. In late 1980, the Community Resource Group in Springdale, Arkansas, set about collecting information through a system called Rural Transportation Information (RTI), a practical rural transit technology transfer program (*13*). The RTI program consisted of the following:

1. A file box with files labeled for unbound material,
2. A file system for bound material, and
3. A file box and system for contacting people in the rural transit field—a collection of some 300 names, from such notables as Arthur Saltzman and Norm Paulhus to local transit managers like Terry Young.

A training conference on how to use the RTI program was held in March 1981 in San Antonio, Texas. Attendees remarked that this was the first time that rural public transit was recognized as an identifiable field of endeavor and study. RTI became the model for the Rural Transit Assistance Program (RTAP).

RTI and the directories of practitioners, administrators, and experts supported the advancement of rural transit as a recognized field of study. At the same time,

A Menominee Regional Public Transit driver assists a passenger at the Tribal Health Clinic, Keshena, Wisconsin. (Photo: Peter Schauer)

it was reported that only 18 of 562 federally recognized tribes received any funding from the Federal Transit Administration (FTA) rural transit program.

It was not until the FTA tribal transit program came into effect in 2006—with a discretionary funding program and a direct funding and application route to FTA, thereby circumventing states—that tribal transit programs grew vigorously, to 132 programs in 2015 (*5*). In 2012, the tribal transit program was revised to include a discretionary and formula component (*6*).

The growth of tribal public transit and the recognition of its importance is summarized in the following report from the National Congress of American Indians on a survey of transit services on reservations: "far from being a mere detail in the tribe's efforts to improve their material well-being and standard of living for their members, viable transit systems is the glue that holds tribal economies and societies together" (*7*).

—Peter Schauer
Boonville, Missouri

REFERENCES

1. Crain, J., and E. Hodson. *Rural Transportation Projects on Indian Reservations: A Report on Eleven Demonstrations*. Report UMTA-MA-06-0049-80-8. U.S. Department of Transportation, 1980, p. A12.
2. Crain and Hodson, p. 5.
3. Crain and Hodson, pp. 44–45.
4. Stoddard, A., D. Sampson, J. Cahoon, R. Hall, P. Schauer, V. J. Southern, and T. Almeida. *TCRP Web-Only Document 54: Developing, Enhancing, and Sustaining Tribal Transit Services—Final Research Report*. Transportation Research Board, 2012, p. 77.
5. Mattson, J. 2017 *Rural Transit Fact Book*. Report SURLC 17-007. Small Urban and Rural Transit Center, Upper Great Plains Transportation Institute, North Dakota State University, 2017, p. 51.
6. FTA Tribal Transit Program. National Rural Transit Assistance Program. www.nationalrtap.org/Tribal-Transit/FTA-Tribal-Transit-Program. Accessed Nov. 12, 2019.
7. National Congress of American Indians, R. Holden, and P. Moorehead, eds. *National Indian Tribal Transit Report*. Federal Transit Administration, U.S. Department of Transportation, March 1996, p. 53.

many advocacy and interest groups beyond those associated with AAAs and CAAs became active in the advancement of both the study and funding of rural transit. The U.S. Department of Agriculture's National Rural Development Council, the National Rural Coalition, the National Rural Center, and (most notably) Rural America all became strong advocates for the funding and implementation of rural public transit. Rural America seemed to capture the most attention with their 1979 report "Research Report 3: Rural Transportation—A Modest Proposal," which offered a different way to plan and implement rural transit (*14*).

TRANSPORTATION CAMP

The advocates who started the successful OATS demonstration in Missouri also recognized that a new way of thinking was needed, and they subsequently founded a concept called "Transportation Camp." For three years beginning in September 1975, OATS sponsored a transportation camp and workshop that brought together hundreds of nonexperts to focus on the rural transit needs of the entire state, not just of the four counties that OATS initially served. OATS rural transit pioneers invited elected officials, state and federal officials, and actual transit riders to Camp Clover Point in Lake of the Ozarks State Park for a three-day camp to discuss transit needs. This was part of the new way of thinking: to involve the potential users in designing and managing the service.

The OATS transportation camp was true citizen advocacy—the highlight and focal point of the event was a discussion of each county's transit needs, as prepared by a local resident of that county (*15*). The people who needed the service organized and advocated to meet their needs and those of their community.

In 1982, Rural America received an Urban Mass Transportation Administration

Photo: TriMet, Flickr

Throughout the 1970s and 1980s, federal, state, and local agencies met with community members to design and manage rural transit programs that would fit the needs of county residents.

(UMTA) discretionary grant to advance rural transit. The UMTA Administrator at the time had desired more practical materials on the implementation and operation of rural transit, so with Rural America's community-based advocacy, a work program was developed. This program combined elements of the OATS transportation camp, RTI, and peer-to-peer exchanges and ultimately resulted in creation of the National Association of Transportation Alternatives (NASTA), the first organization focused on rural public and community transportation. Eventually, both NASTA and Rural America combined to form a new organization, Community Transportation Association of America, which continues today.

In 1987 the Surface Transportation and Uniform Relocation Assistance Act was passed. The transit appropriations bill included $5 million per year for five years to implement RTAP, which in many ways formalized the RTI concept along with elements of Rural America's first UMTA discretionary grant. According to the 1987 UMTA Acting Director Alfred DelliBovi, "RTAP will have a wide range of activities such as training courses; 'circuit riders' to give onsite training on safety, maintenance, management, etc.; peer-to-peer networks; information exchanges such as computer bulletin boards; and newsletters" (*16*).

RTAP has continued well beyond those initial five years and serves as a reminder of the effectiveness of peer group assistance and the evolution of rural transit. Through an advisory board of state RTAP managers and rural transit practitioners, the program remains focused on practical and rural transit training needs. The systematic manner in which RTAP has catalogued information and shares it through a website, conferences, and one-on-one technical assistance has made it a unique resource that has no equivalent activity in the field of urban transit.

Conclusion

Rural transit emerged via forces quite different from those that gave rise to urban transit. Urban transit has had a long-standing role in cities that dates back hundreds of years; rural transit came about only decades ago, spurred by the lack of commerce, available services, growth, and development in rural areas. People in rural areas needed services, and social service providers discovered that they needed to be transit providers. Social service agencies still are key providers of rural transit, through contracts that provide large revenues to match federal grants.

Without the 1985 amendment to the UMTA that allowed social service contract revenues to be used as a match, it is likely that transit would have a different, less-expansive role in rural America. It was advocacy by people—often riders of rural transit who brought issues of equity before Congress in the early 1970s—that resulted in dedicated federal funding. Today, researchers, policymakers, and politicians explore rural and urban equity issues, and the need for transit funding of all types remains paramount, especially to the people addressed by the OAA and EOA.

REFERENCES

1. Smerk, G. M. Public Transportation and the City. In *Public Transportation*, 2nd ed. (G. E. Gray and L. A. Hoel, eds.), Prentice Hall, Englewood Cliffs, N.J., 1992, pp. 3–23.
2. Dejean, J. *How Paris Became Paris: The Invention of the Modern City*. Bloomsbury, New York, 2014, p. 126.
3. Saltzman, A. Public Transportation in the 20th Century. In *Public Transportation*, 2nd ed. (G. E. Gray and L. A. Hoel, eds.), Prentice Hall, Englewood Cliffs, N.J., 1992, pp. 24–45.
4. Rural America Factsheet #6: Public Transportation. Rural America Organization, Washington, D.C. Circa 1978.
5. Michel, J.-B., et al. Quantitative Analysis of Culture Using Millions of Digitized Books. *Science,* Vol. 331, No. 6014, 2011, pp. 176–182.
6. History. Connecticut Association for Community Action. www.cafca.org/history. Accessed October 31, 2019.
7. Rosenbloom, S. The Transportation Disadvantaged. In *Public Transportation*, 2nd ed. (G. E. Gray and L. A. Hoel, eds.), Prentice Hall, Englewood Cliffs, N.J., 1992, pp. 583–616.
8. Dempsey, P. S. *The Social and Economic Consequences of Deregulation: The Transportation Industry in Transition.* Greenwood Press, Westport, Conn., 1989, p. 385.
9. D. Yeager, personal communication, Nov. 1, 2019.
10. Schauer, P. Rural Public Transportation. In *Public Transportation*, 2nd ed. (G. E. Gray and L. A. Hoel, eds.), Prentice Hall, Englewood Cliffs, N.J., 1992, pp. 407–444.
11. Mattson, J. *2015 Rural Transit Fact Book.* Report SURLC 15-001. Small Urban and Rural Transit Center, Upper Great Plains Transportation Institute, North Dakota State University, 2015.
12. FY 1980 Sec. 18: Use It or Lose It. *Rural Transportation Reporter*, Vol. 1, No. 4, Aug. 1983, p. 1.
13. Schauer, P. *Rural Transportation Information: User Guide.* Community Resource Group, Springdale, Ark., 1981.
14. Moore, J. *Rural Transportation: A Modest Proposal.* Research Report 3. Rural America, Feb. 1979, p. 1.
15. First Annual Missouri Transportation Workshop. Sept. 1975, p. 14.
16. The Rural Transit Assistance Program: A New, National Training Resource. *Community Transportation Reporter*, Vol. 5, No. 7, July–August 1987, p. 8.

SUPPORTING BURNING MAN

RADICAL LOGISTICS FOR A RADICAL EVENT

Photo: National Renewable Energy Lab

MATTHEW GRUNENWALD

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Above: The Burning Man Festival is a small city—with an airport and other infrastructure—that appears in the middle of the Nevada desert each August to celebrate art, music, and community.

Each summer, tens of thousands of people journey to the Nevada desert by land and by air to participate in a unique event. For one week, the volume of traffic on nearby desert roads and at an otherwise sleepy airport rivals the operational volume at some of the largest highways and commercial airports in the country. A modern-day Brigadoon—the mythical Scottish town that magically appears and disappears once every 100 years—the event is known as the Burning Man Festival in Nevada.

What Is Burning Man?

Perhaps its questionable reputation precedes this article. The event's website provides some insight, starting with a "Welcome Home" message presented in multiple languages (*1*). Burning Man is an art festival, a music venue, a community, and is located in the desert—but what is it, really?

Burning Man is an experimental art community event held annually in late August and early September on the Black Rock Desert playa in Nevada. A group of friends held the first event in 1986 on a beach outside San Francisco, California, intending it as a means of expressing youthful angst by burning a wooden effigy, the "Man," as a symbol of release—physical, mental, emotional, and spiritual. Attendees spontaneously sang, danced, and told stories.

Today, Burning Man is based on principles that support a community organized on the idea that all art activities, transportation, food, clothing, and shelter are provided by the individual participants. Within the greater community of Burning Man are thousands of individuals who pool resources and assemble at themed camps or in groups sharing common interests or modes of expression.

Burning Man brings people together from all over the world to challenge their traditional realities through art, entertainment, and other activities. The event has grown to include 80,000 annual participants, or "Burners," on the Black Rock Desert playa (see Figure 1, page 18) near

Photo: Rusty Blazenhoff, Flickr

A small aircraft arrives at the Burning Man encampment.

Photo: Duncan Rawlinson.co

Traffic to and from the event can cause a 10-hour drive through the playa.

the northwest Nevada town of Gerlach, population 206 (2). This area is part of the High Rock Canyon national conservation area and is managed by the Bureau of Land Management (*3*). Although not the most hospitable of places, it is the site of Burning Man's annually established community, Black Rock City, which brings life to the area for one week in late summer.

Far from being disorganized and haphazardly assembled, Black Rock City is formed within a pentagon-shaped boundary. Living areas are arranged in a circular layout that stretches across the 2 miles of the city. Streets, avenues, art—everything is carefully organized for easy navigation. The incongruence of its painstaking organization with its brief existence offers many lessons—especially from the creation, management, and removal of Black Rock City Municipal Airport.

FIGURE 1 Black Rock Desert Playa.

Preparing for Burning Man

Because the festival is in such a remote place, travel to and from the event is an experience in itself. Vehicle traffic on opening day and exit weekend is so heavy that car travelers can easily exceed 8 to 10 hours in line just to leave the playa—this in addition to the drive down Nevada SR-447 through Gerlach, across the Pyramid Lake area, and back to civilization. These roads were never intended to handle the volume of traffic that they now see before and after the event. Consequently, a considerable amount of planning and organization is needed to prepare for such traffic volume.

For most people, Burning Man festival is nine days in the desert, but the Burning Man organization recruits hundreds of volunteers and spends thousands of hours over the entire year reviewing feedback and adjusting the design of Black Rock City for the next year's event. Paved highways lead to the entrance of the playa, but although the asphalt ends there, the drive does not. Ten surveyed lanes, marked with traffic cones and flag tape, stretch across 5 miles of playa dust, funneling the cars, buses, recreational vehicles, and cargo vehicles to the front gate entrance. Volunteers begin installing these lanes and other needed infrastructure as early as June, after the seasonal flood waters on the playa subside. Many work weekends are spent planning for and moving massive amounts of equipment, supplies, building materials, heavy construction equipment, and storage or sleep containers into place.

Upon arrival at the festival, passengers in every vehicle are greeted by a gate attendant with a warm hug, a "welcome home," and the opportunity to ring a bell after making a dust angel on the ground—an introductory rite proclaiming an attendee's first participation in the event. Attendants also ensure arrivals have tickets for each occupant of the vehicle, along with sufficient provisions of food, clothing, shelter, and water. Each participant receives a guidebook with key information, from location of medical facilities to yoga session times to where to get the perfect cup of Oolong tea at 2 p.m. each day.

Black Rock City Airport

In adherence to the principles of Burning Man, Burners who are pilots historically sought to reduce their travel time by flying in and out of the event, using open space on the playa to land and store their aircraft. Over time, this mode of transportation attracted additional attendees. What started as a self-reliant travel method evolved into a regional airport that now serves the more than 4,000 Burners who use some form of air travel to get to the festival.

The airport is just one part of the transportation network that continually

Photo: Rusty Blazenhoff, Flickr

More than 4,000 travelers arrive at Burning Man by plane.

Photo: Duncan Rawlinson.co

Airport runways, taxiway access, and ramp spaces are designed months before the event, using traffic cones, temporary fencing, or flags.

recreates itself each year. Located 1.5 miles from Black Rock City, Black Rock City Municipal Airport (assigned the international airport code K88NV) consists of more than 100 general aviation aircraft, hundreds of volunteers, three runways, four heliports, and multiple fuel farms, as well as charter operations and medical services. The airport is staffed by a team of volunteers who manage the operations and handle all related safety and medical logistics. Many of these Burners work in the aviation industry and collectively possess the skills, knowledge, and ability for the Burning Man community to operate an airport.

WORK OF THE AIRPORT TEAM

The airport team is hard at work as soon as the previous year's festival ends. The airport team meets to collect feedback, identify what did not work, and strategize on best practices. The airport staff core team shares feedback through online options—many Burning Man participants are from Silicon Valley, so technology is a ready solution—as well as biweekly staff meeting calls and quarterly face-to-face retreats. Most of the costs to participate in the festival are borne by attendees on an individual basis, and this encourages creative approaches—necessity oftentimes being the mother of invention.

During the June work weekends, professional surveyors volunteer to laser survey the runway alignments and ramp spaces, using specific measurements for length, width, and taxiway access, along with short- and long-term parking for large and small aircraft of all types. All of these areas are clearly marked with traffic cones, temporary fencing, or flag ribbons. Other teams arrive in trucks bearing sheds; building materials; and storage containers filled with tools, supplies, electric generators, and disassembled structures that need to be placed, reconstructed, and powered.

Overshadowing everything the airport team must deal with before, during, and after Burning Man is the issue of rising dust from continuous impact by vehicle and aircraft tires, propellers, and rotor blades. Water trucks during the event help keep the dust down; afternoon wind and dust storms are common on the playa.

Photo: Rusty Blazenhoff, Flickr

Rising dust from the desert is a constant challenge for pilots and organizers.

CONTROL TOWER

A temporary air traffic control tower is constructed and staffed by professional air traffic controllers and trained volunteers. Because of the concentration of aircraft arriving, departing, and transiting the area, flight procedures have been established that all pilots using the airport must use. They are required to study, be tested on, and understand the procedures before arrival.

Three separate radio frequencies for arrivals and departures, the tower, and the ground are used to track all aircraft in the area associated with Burning Man. Airport staff also must track aircraft that are not part of the event, including those using the adjacent military airspace and curious onlookers in overflying aircraft. These nonparticipants must be identified quickly and their whereabouts communicated to all Burner-related air traffic.

Burner Express

For Burners who wish to travel by air rather than by land, Burner Express is a contract charter air transportation service that transports Burners from the California cities of Burbank, San Carlos, and Oakland and from the Nevada cities of Reno and Las Vegas. Burner Express facilitates the flight bookings for passengers for an additional fee, one not included in the Burning Man ticket price. Aside from being a faster form of transportation, air travel reduces traffic on the already-congested roadways to Black Rock City.

Photo: Duncan Rawlinson.co

Temporary control towers are constructed and staffed by professional air traffic controllers and trained volunteers.

Photo: Duncan Rawlinson.co

Despite the temporary nature of the airport, passengers still go through gate security to ensure safety.

All participants understand that the complexity of this situation, if managed poorly, can result in very serious consequences.

Black Rock City Municipal Airport is included in the Federal Aviation Administration (FAA) Klamath Falls aeronautical sectional chart as a private airport. It is actively overseen by FAA's Reno and Oakland Flight Standards District Offices, as well as the Oakland Air Route Traffic Control Center, which controls the overlaying airspace. Permission to land at the airport requires pilots to pass a knowledge test online in advance. These pilots then receive an authorization code and, when landing, present this code over the arrival frequency with their intent to land.

Once cleared to continue flying in, pilots announce their position using the assigned radio frequency and follow standardized arrival procedures described during the online test. These procedures ensure adequate spacing for inbound and outbound traffic, larger and smaller aircraft, and scenic tours that may be flying around the city at any time.

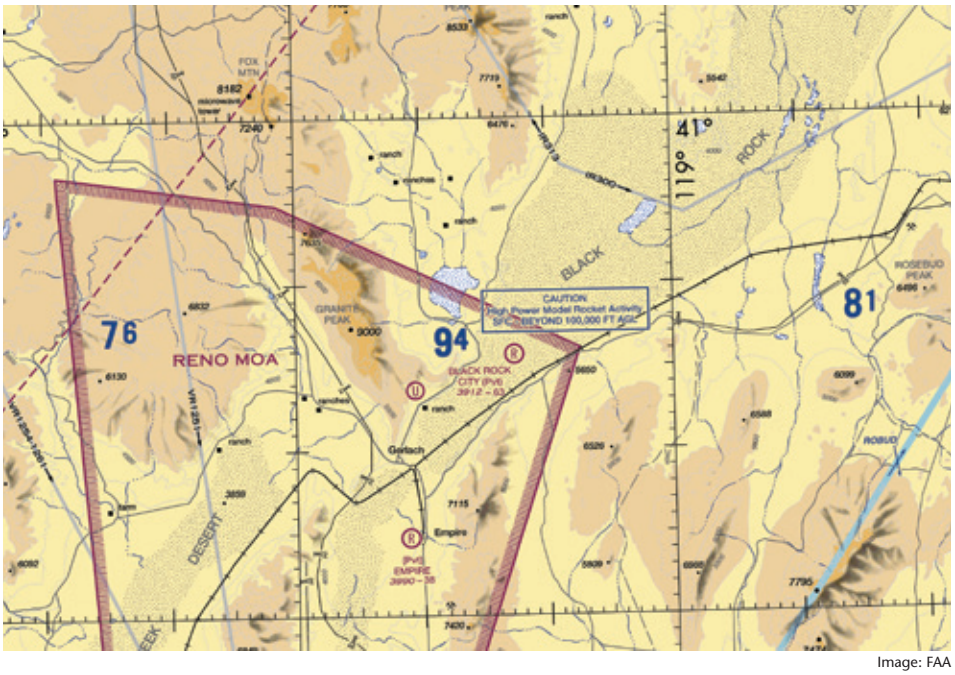


Image: FAA

The FAA Klamath Falls aeronautical sectional chart displays Black Rock City Municipal Airport as a private airport. It is situated within the Reno military operations area, or MOA, airspace.

RUNWAYS

Two professionally surveyed runways are used during the event—one for large aircraft and the other for small aircraft. The airport is operated under general aviation and air charter rules (no commercial airline service is provided) and can accommodate a range of operations, including scenic flights, medical flights, unmanned aerial vehicles, ultralight aircraft, parachute jumping, and overflying military aircraft. As at many airports in the United States, 24-hour ramp and gate security ensure the safety both of aircraft and of the participants.

Black Rock City Municipal Airport also has a designated area reserved for chartered flights, a ticketing and customs area, and a waiting area for those wishing to take scenic flights being offered by fellow Burners. Transportation to and from the airport is provided during the week by volunteer art car drivers. Passengers never know if they will be picked up in a vehicle resembling a land yacht or trolley car—or by a driver sporting a space alien head covered in fur. Bicycles—the primary means of transportation at Burning Man—are available free of charge, on a "use as needed" rack.

Records show that more than 3,600 arrival and departure operations occurred during the 2018 Burning Man event, even though the airport only operated during the day and in good weather conditions. Additionally, more than 5,800 passengers used the Burner Express, representing more than 7% of the total Black Rock City population for that year.

Principles of Burning Man Festival

The following is a summarization of the 10 principles as written by the Burning Man founder Larry Harvey in 2004:

1. Radical inclusion means that all people are welcome, regardless of different backgrounds.
2. Giving reflects the intent both to give and to receive freely. Gifts can be virtually anything, from a hug of encouragement to a meal.
3. Radical self-reliance means that each Burner is responsible for their own food, clothing, shelter, medical supplies, water, sunscreen, decisions about activities, and safety.
4. Decommodification strips away the commercialization, branding, and monetizing of everything. The only things that money buys at Burning Man are coffee and ice, which are available at Center Camp.
5. Radical self-expression encourages participants to be and express themselves as they are. Self-expression can be a challenge to new Burners, who may see the event as a spectator sport instead of as a participation event.
6. Communal effort means that everything is a collective effort. "No man is an island" takes on real significance in a community bound together for its collective existence.
7. Civic responsibility ensures that each community member assumes responsibility for their community. Participants should lead by example and behave according to local, state, and federal laws.
8. "Leave no trace" means that, once complete, the event disappears into the desert without any indication that a very large community had been established and had thrived there for more than a week.
9. Participation invites all Burners to engage in work and play. The community grows, with each participant contributing.
10. Immediacy means engagement in daily activities, along with being fully present and connected to other Burners in the moment.

The original text can be viewed at https://burningman.org/culture/philosophical-center/10-principles.

Comparative data for commercial airline service airports in Nevada the same week in 2018 (for both day and night operations and in all weather conditions) show that Las Vegas had 12,966 operations, North Las Vegas had 4,722 operations, and Reno had 3,686 operations (*4*).

Leaving No Trace

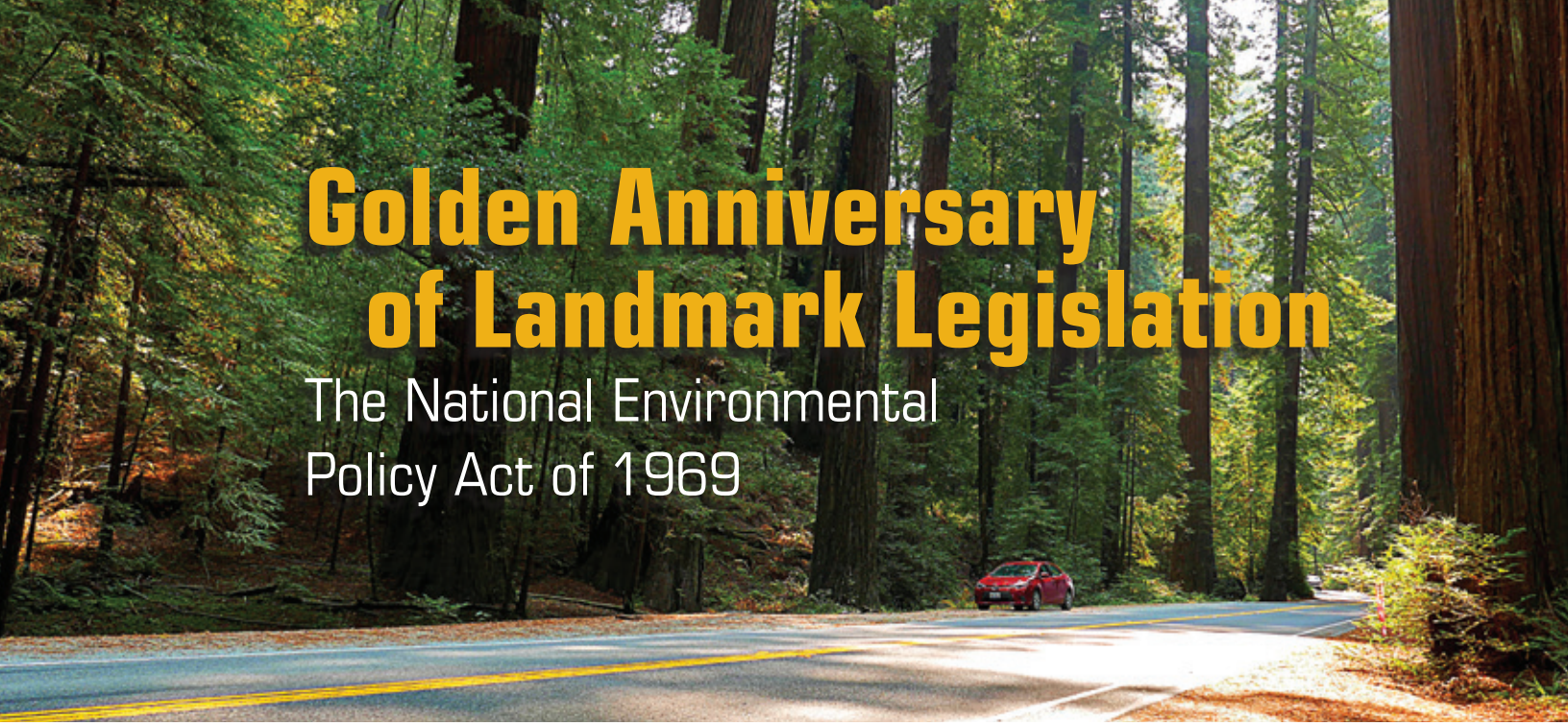
All good things eventually must end, and the end of the festival occurs with the burning of the Man. So who cleans up? Given the festival's impact on the playa, the neighboring towns of Gerlach and Pyramid Lake, and nearby highways, Burning Man event organizers partner with local areas and the Bureau of Land Management to ensure that the playa is restored to its former state. The goal is that the only traces of the event remain in photos and in the minds of the attendees. Cleanup requires another group of volunteer Burners, who help maintain the balance with the communities that share the playa as a resource.

At the airport, specific volunteers—some of whom have now spent a month or more on the playa—lead the deconstruction of the event. These individuals see to it that every aspect of the "leave no trace" principle is fulfilled. Teams walk the length of the runways to remove any debris generated from aircraft landing or caused by aviation operations. The fences come down, the buildings and structures are disassembled, and the traffic cones are picked up. Everything is organized into storage containers that will once again be hauled offsite, where they will wait to be reopened, accounted for, and reconstructed for another Burn.

This article is adapted from a presentation by the author at the 98th TRB Annual Meeting in January 2019. For more information, visit https://annualmeeting.mytrb.org/interactiveprogram/Details/10940.

REFERENCES

1. Welcome Home. Burning Man, 2019. www.burningman.org. Accessed Oct 23, 2019.
2. Gerlach, Nevada. City-Data.com, 2019. www.city-data.com/city/Gerlach-Nevada.html. Accessed Oct 23, 2019.
3. Black Rock Desert–High Rock Canyon Emigrant Trails NCA. Bureau of Land Management, U.S. Department of the Interior, 2019. www.blm.gov/programs/national-conservation-lands/nevada/black-rock-desert-high-rock-canyon-emigrant-trails-nca. Accessed Oct 23, 2019.
4. Air Traffic Activity System (ATADS): Airport Operations. Federal Aviation Administration, 2019. https://aspm.faa.gov/opsnet/sys/Airport.asp. Accessed Oct 23, 2019.



Golden Anniversary of Landmark Legislation

The National Environmental Policy Act of 1969

MARTIN PALMER

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Above: The Redwood Highway cuts through California's Redwood Forest. The development and implementation of the National Environmental Policy Act (NEPA) has balanced the need for transportation infrastructure and the need to protect the environment.

Sometimes referred to as the "environmental Magna Carta," the nearly 3,000-word National Environmental Policy Act of 1969 (NEPA) was signed into law on New Year's Day 1970 by President Richard Nixon (*1–3*). It was the world's first comprehensive national policy on the environment. In the 50 years since NEPA was signed, many laws, rules, and guidance documents would be revised in accordance with the new national policy.

Need for Legislation

The years leading up to the passage of NEPA legislation were accompanied by a growing national awareness of the state of the environment. Major calamities—human-caused and with significant impacts on the environment—fueled public discontent and helped shift the civil and political landscape (see Figure 1, below).

Major catalyzing events included biologist Rachel Carson's book *Silent Spring*, published in September 1962,

FIGURE 1 One of 13 known fires on the Cuyahoga River in Cleveland, Ohio, between 1868 and 1969 that was due to chemical waste. The river was so well known for its foul water that city residents barely took notice of the 20-minute event. It was not until *Time* magazine ran an article on the river fire did the incident garner national attention and become a rallying cry for the environmental movement. (Source: Grant, J. "How a Burning River Helped Create the Clean Water Act." *Allegheny Front*, Apr. 17, 2015. Image: Michael Schwartz Library, Cleveland State University.)

"The great question of the seventies is, shall we surrender to our surroundings, or shall we make our peace with nature and begin to make reparations for the damage we have done to our air, to our land, and to our water? Restoring nature to its natural state is a cause beyond party and beyond factions. It has become a common cause of all the people of this country. It is a cause of particular concern to young Americans, because they more than we will reap the grim consequences of our failure to act on programs which are needed now if we are to prevent disaster later."

–President Richard Nixon, Jan. 22, 1970

which documented the devastation caused by the use of the insecticide DDT; the chemical waste–induced fire on the Cuyahoga River in Ohio in 1969; and the 3-million-gallon oil spill near Santa Barbara, California, in 1969, which created a 35-mile oil slick along the California coast and killed thousands of birds, fish, and sea mammals (*4–6*).

Legislative Path for Change

U.S. Sen. Henry M. "Scoop" Jackson (D-Washington), who also had served in the U.S. House of Representatives from 1941 to 1953, was a well-known champion of natural resources. Jackson had witnessed with frustration how, at times, government agencies with differing missions worked in unwitting opposition to one another. He soon realized that no mechanisms were in place to bring federal agencies together or to oblige them to address their impacts on natural resources. Federal agencies also were seen by the public as major polluters, both because of their direct actions and because they had issued questionable approvals (*2–3, 7*).

Jackson chaired the Senate Committee on Interior and Insular Affairs, which at the time had jurisdiction over vast land areas that contained much of the nation's prized natural and historic resources. In July 1968, Jackson called for a joint U.S. House–Senate conference to determine ways to get government agencies to coordinate their efforts and address the environmental impacts of their actions (*3, 7*). He had found an ally in the House of Representatives: U.S. Rep. John Dingell (D-Michigan), who introduced their measure to the House on February 17, 1969. After several committee hearings and debates, the House amended the bill and eventually passed it by a vote of 372–15 on September 23, 1969 (*3*).

On the Senate side, Jackson introduced his bill the day after Dingell. At this time, the bill did not have a declaration of a national policy nor did it have a mandate for agencies to declare and make public the resulting impacts of their actions. After several hearings in Jackson's committee, the amended measure went to the Senate floor for a vote on July 10, 1969. The bill passed unanimously (*3*).

Jackson's bill soon caught the ire of U.S. Sen. Edmund Muskie (D-Maine), an active member of the Senate Public Works Committee. Muskie's dispute with Jackson was twofold: first, Muskie was coauthoring amendments to the Federal Water Pollution Act (FWPA) and

Photo courtesy Martin Palmer

U.S. Sen. Henry M. Jackson (*right*) championed the protection of natural resources and authored NEPA.

felt that Jackson's bill would interfere with provisions in the FWPA; second, the Public Works Committee was tasked with matters related to the environment and infrastructure and Muskie perceived Jackson's actions as a challenge. Both senators were well known for their environmental advocacy and it was through the Public Works Committee that Muskie had advanced most of his environmental agenda (*2*).

Eventually, the senators worked out their differences. From their many discussions came the provision requiring federal agencies to produce a statement on the environmental impacts of their undertakings—often called the heart of NEPA. Jackson amended his bill with the compromise language (*2*).

The House and Senate versions of the bill eventually went to conference committee, which resolved the differences between the bills on December 17, 1969. The Senate passed the final compromise bill on December 20, 1969, and the House passed the bill three days later, just before Congress' Christmas recess. Nixon signed the legislation on January 1, 1970. Since then, more than 100 countries have adopted similar environmental policies.

What Is NEPA and How Is It Regulated?

NEPA is enormously broad and elegantly simple: it asks project proponents to consider and determine their actions' effects on the environment. Agencies must determine if the action will have a significant effect on the quality of the natural and human environment. If the answer is "yes," then the agency must prepare a detailed statement on reasonable alternatives that may exist and the impacts from each of the alternatives. The agency then must make a decision on what they are going to do and explain why they made that choice. Certain milestone documents and actions are subject to public comment. If the action does not have a significant effect on the quality of the natural and human environment, then the action is deemed to comply with NEPA.

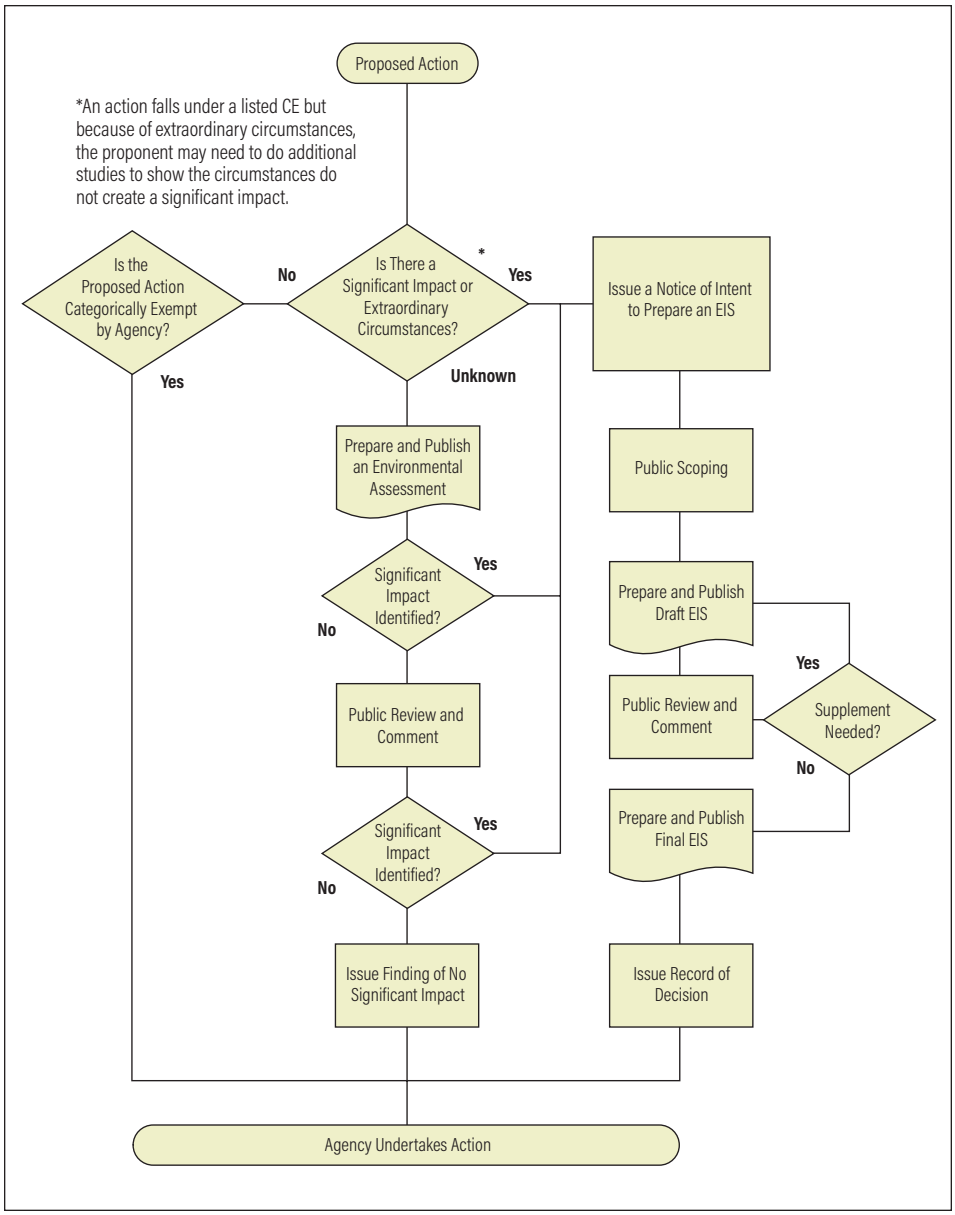

FIGURE 2 Overview of the NEPA process (*1*). (CE = categorical exclusion; EIS = environmental impact statement)

After careful consideration, an agency may also determine that actions of a certain type, either individually and or cumulatively, will not have a significant effect on the natural and human environments. These actions are then categorically excluded from the NEPA process (see Figure 2, above).

NEPA definitively changed how federal and state agencies approached their actions. Soon after the legislation was passed, agencies began incorporating environmental considerations into their actions and business models. Government entities established environmental offices. Eventually, federal and state departments of transportation changed their standard operating procedures to enhance their environmental compliance.

Government agencies also became more transparent in their decision-making, integrating community engagement as a way of life. The incredible change in how transportation projects are addressed would not have happened without NEPA (*8*).

Establishing the Regulatory Path

COUNCIL ON ENVIRONMENTAL QUALITY

With NEPA came the Council on Environmental Quality (CEQ). A division of the Executive Office, the council oversees implementation of NEPA throughout the federal government. In its unique place among federal agencies, CEQ interprets relevant regulations, issues guidance on procedural requirements, resolves disputes between government agencies, advises the President on environmental matters, approves NEPA procedures of federal agencies, and authorizes special arrangements for NEPA compliance in emergencies. The chair of CEQ also assists the President in developing environmental directions and programs.

Working closely with federal agencies and various other groups, CEQ advances the President's environmental initiatives. In its early years, CEQ laid the foundation for much of the today's environmental legislation. It was influential in advancing amendments to the Federal Water Pollution Control Act, the Safe Drinking Water Act, and other legislation dealing with pesticides and toxins. The council focuses on implementing current presidential initiatives in the One Federal Decision Executive Order of 2017, which coordinates federal environmental review and permitting processes for major infrastructure projects (see Figure 3, at right), and on addressing its applicability in special cases, such as to states granted authority to assume the U.S. Transportation Secretary's responsibilities under NEPA for highway projects (*9*).

ENVIRONMENTAL PROTECTION AGENCY

Soon after NEPA was passed, Nixon presented to Congress an aggressive 37-point plan designed to address the nation's concerns on the environment. Among these points were

- Establishment of standards and initiating research for lowering motor vehicle emissions;
- Institution of national ambient air quality standards;

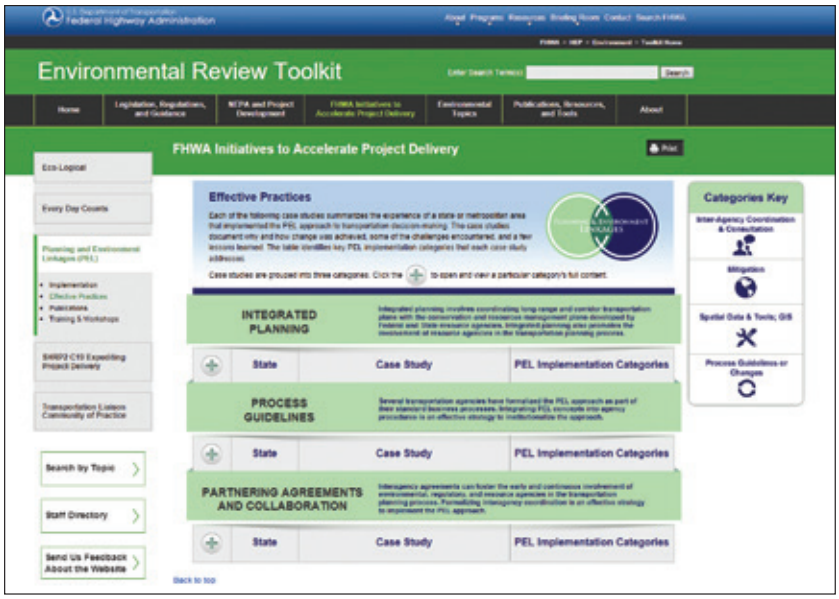

FIGURE 3 Screenshot of the Federal Highway Administration Environmental Toolkit. (Source: FHWA.)

- Call for billions of dollars to improve water treatment facilities across the country;
- Development of a strategy for cleaning up the Great Lakes;
- Imposition of reforms on polluting federal facilities; and
- Development of a national plan to address oil spills.

Nixon also created the Advisory Council on Executive Organization, also known as the Ash Council, to recommend organizational changes to improve the efficiency of government in delivering his domestic agenda. In a memo dated April 29, 1970, the Ash Council recommended that Nixon centralize key federal antipollution programs into a single entity: the Environmental Protec-

Photo: Office of Response and Restoration

President Richard Nixon's 37-point environmental plan addressed motor vehicle emissions, water treatment, and oil spills.

tion Agency (EPA), a new and independent organization within the executive branch. The council's memo recalled the president's February 10, 1970, pledge to repair the damage done to the environment and to establish a new direction for the country. EPA was created to deliver on that promise (*10–11*).

Nixon accepted the Ash Council's recommendations and sent a plan to Congress that placed the federal government's environmental responsibilities in the hands of a single agency. This change would make it possible to address environmental problems in a comprehensive way that had not been possible when it was the responsibility of many separate agencies. Nixon charged the first EPA administrator with a holistic examination of the environment. No longer would different forms of pollution be considered different problems—they would be seen and addressed as a single challenge. EPA was to act as the "enforcer" of environmental statutes passed by Congress (*12*).

Beyond enforcement, EPA is responsible for protecting human health and fostering a productive natural environment. The agency also is tasked with performing scientific research and setting national standards to protect sensitive human populations.

Looking to the Future

In the 50 years since NEPA was passed, federal agencies and the government have passed additional legislation, issued executive orders, and developed thousands of pages of guidance documents and educational tools to help states meet the goals envisioned under NEPA. Some agencies have attempted to "modernize" how they implement NEPA by adopting tools and processes such as intergovernmental collaboration agreements, programmatic analyses, tiered documentation requirements, and adaptive management and monitoring approaches (*13–14*).

No one can predict how changing needs and circumstances may shift national policy, but it is clear that research can help decision-makers choose an appropriate course for the next 50 years. Good science can aid in making objective and meaningful proposals.

Although many agencies and organizations have considered updating and modernizing NEPA, information is needed on the benefits, impacts, and costs resulting from the legislation, particularly when separating compliance from other environment-related requirements, such as the Endangered Species Act (*15–17*). One opportunity for research may be to examine the data needed—and from what source—to determine how to isolate and therefore assess the cost and time required for the NEPA process separate from related requirements. This may extend to potential revisions to the legislation itself so would need to be a long-term study conducted in cooperation with a number of state and federal agencies.

Although federal agencies continue to produce thousands of pages of guidance documents and educational resources, a past CEQ study suggested that confusion among practitioners as to the true purpose of NEPA may lead to implementation that falls short of its intended goals (*17*). More research is needed to help organizations, including states, to focus on producing reports that result in appropriately informed decisions through better environmental analysis of project needs and impacts.

Another potential area of research is the reexamination of the data sets available to stakeholder agencies. Technological advancements in available equipment

In 1989, the U.S. Forest Service planned to clear-cut every aspen grove in Grand Mesa, Uncompahgre, and Gunnison National Forests in Colorado to facilitate a waferboard plant. After a record-setting response during NEPA's comment period, many of the trees were saved.

(for example, drones) and powerful data analytics make it viable to collect and characterize large amounts of reliable and robust data affordably and in less time.

Various initiatives have been launched to develop statewide environmental databases for soil types, vegetative cover, wetlands, streams, historical and archaeological sites, threatened and endangered species, parks and recreational sites, waste sites, floodplains, and various socioeconomic data. Unfortunately, no single platform yet exists whereby data from many disciplines can be pooled together and analyzed in an integrated fashion. Research is needed to understand how such data can be developed and organized to benefit community planning and project-level decision-making.

Acknowledgments

The author thanks Peter Jackson and Carol Vipperman at the Henry M. Jackson Foundation for their help, information, and photographs related to the late Sen. Henry (Scoop) Jackson and the development of NEPA. The author also thanks William C. Barrow, Head of Special Collections at the Michael Schwartz Library, Cleveland State University, for information and photos of Cleveland and the Cuyahoga River from the library's Cleveland Press Collection.

REFERENCES

1. National Environmental Policy Act of 1969, 42 U.S.C. § 4321 et seq (1969).
2. Kershner, J. NEPA, the National Environmental Policy Act. *HistoryLink.org*, Aug. 27, 2011, www.historylink.org/File/9903. Accessed Oct. 8, 2019.
3. Luther, L. G. *The National Environmental Policy Act: Background and Implementation*. CRS Report for Congress RL33152. Congressional Research Service, Library of Congress, 2005.
4. Griswold, E. How "Silent Spring" Ignited the Environmental Movement. *New York Times Magazine*, Sept. 21, 2012, www.nytimes.com/2012/09/23/magazine/how-silent-spring-ignited-the-environmental-movement.html.
5. Mai-Duc, C. The 1969 Santa Barbara oil spill that changed oil and gas exploration forever. *Los Angeles Times*, May 20, 2015, www.latimes.com/local/lanow/la-me-ln-santa-barbara-oil-spill-1969-20150520-htmlstory.html.
6. Miller, M. The Oil Spill That Sparked the Green Revolution. *Los Angeles Times*, Nov. 30, 1999, www.latimes.com/archives/la-xpm-1999-nov-30-me-38862-story.html.
7. Biographical Directory of the United States Congress. Jackson, Henry Martin (Scoop), (1912–1983). http://bioguide.congress.gov/scripts/biodisplay.pl?index=j000013. Accessed Oct. 8, 2019.
8. Alm, A. L. 1988 Article on NEPA: Past, Present, and Future. *EPA Journal*, January–February 1988.
9. Environmental Protection Agency. Fast-41 & One Federal Decision Project Coordination: Fixing America's Surface Transportation (FAST) Act. www.epa.gov/streamlining-permits/fast-41-one-federal-decision-project-coordination. Accessed Oct. 24, 2019.
10. Stenzel, P. L. Environmental Protection Agency. *Encyclopedia of Business*, 2nd ed. www.referenceforbusiness.com/encyclopedia/Ent-Fac/Environmental-Protection-Agency-EPA.html. Accessed Dec. 2, 2019.
11. Executive Office of the President. Ash Council Memo. April 29, 1970. https://archive.epa.gov/epa/aboutepa/ash-council-memo.html. Accessed Dec. 2, 2019.
12. Lewis, J. The Birth of EPA. *EPA Journal*, November 1985.
13. U.S. Council on Environmental Quality. *Modernizing NEPA Implementation*. Executive Office of the President, 2003.
14. Mandelker, D. R. The National Environmental Policy Act: A Review of Its Experience and Problems. *Washington University Journal of Law and Policy*, Vol. 32, 2010, pp. 293–312.
15. *National Environmental Policy Act: Little Information Exists on NEPA Analyses*. Report GAO-14-369. U.S. Government Accountability Office, 2014.
16. Luther, L. G. *Background on NEPA Implementation for Highway Projects: Streamlining the Process*. CRS Report for Congress RL32024. Congressional Research Service, Library of Congress, 2003.
17. U.S. Council on Environmental Quality. *National Environmental Policy Act: A Study of Its Effectiveness After 25 Years*. Executive Office of the President, 1997.

SEVENTEEN YEARS OF ENVIRONMENTAL RESEARCH

RETROSPECTIVE OF A LONG-RUNNING PROJECT

Photo: Mauro, Flickr

ANN HARTELL AND CHRISTOPHER VOIGT

Hartell is Senior Program Officer, Transportation Research Board, Washington, D.C., and member of the *TR News* Editorial Board. Voigt is Senior Environmental Engineer, Virginia Department of Transportation, Richmond.

Above: The Hoover Dam Bypass was designed to address environmental concerns. NCHRP Project 25-25 examined transportation issues in light of the environment and sustainability.

In 2003, the American Association of State Highway and Transportation Officials' Special Committee on Research and Innovation (R&I, formerly the Standing Committee on Research), the governing body for the National Cooperative Highway Research Program (NCHRP), initiated NCHRP Project 25-25, "Research for the AASHTO Committee on Environment and Sustainability." NCHRP Project 25-25 addressed environmental issues relevant to state departments of transportation (DOTs) and, as a continuing project, was directed by a rotating oversight panel of individuals from state DOTs with diverse expertise in environmental practice. The purpose of the project was to support agency efforts in environmental stewardship and compliance. Individual research tasks conducted under the project, or Tasks, were narrowly focused in order to provide state DOTs with timely research results.

NCHRP Project 25-25 supported 113 Tasks. The total funding was approximately $10 million, the average Task budget was $84,400, and the average Task duration was 12–14 months. Final reports for the remaining Tasks are expected to be released in 2020. Since 2018, environmental research needs have been considered along with all other research topics in the NCHRP main program.

NCHRP 25-25 Tasks addressed a wide range of environmental topics. Figure 1 (below) presents the share of Tasks by topic area. A few Tasks are highlighted by subject area below.

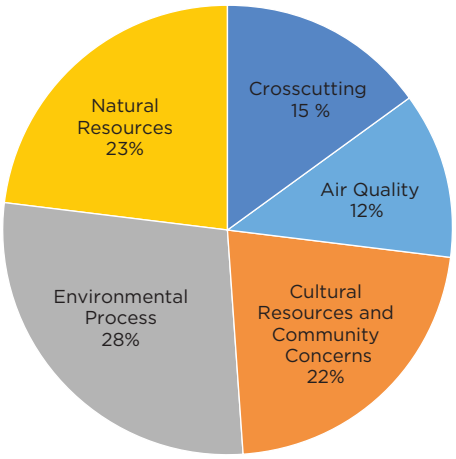

FIGURE 1 NCHRP Project 25-25 Tasks by topic area (2003–2019).

Air Quality

In the area of air quality, NCHRP 25-25 Tasks often focused on methods to improve and streamline air quality analyses and to provide state DOTs with information on new air quality regulations.

One recent assignment was NCHRP 25-25 Task 108, which developed a new, spreadsheet-based toolkit to simplify emission reductions modeling for 15 typical project types that may be funded under the Federal Highway Administration's (FHWA's) Congestion Mitigation and Air Quality Improvement Program (CMAQ).[1] The new, simplified toolkit can save state DOTs and other transportation agencies significant time and cost for CMAQ analyses, as it allows them to enter basic project information and quickly obtain estimates of emission reductions suitable for reporting to FHWA.

Other Tasks related to air quality include the development of programmatic agreement templates for streamlining National Environmental Policy Act–related carbon monoxide modeling, also saving time and costs for state DOTs. The templates initially were developed under Task 78, "Programmatic Agreements for Project-Level Air Quality Analyses Using MOVES, CAL3QHC/R, and AERMOD" in 2015, and were updated and expanded under Task 104, "Streamlining Carbon Monoxide Project-Level Air Quality Analyses with Programmatic Agreements" in 2019.[2–3] In addition, the Task 96 study, "Quick Reference Guide for Traffic Modelers for Generating Traffic and Activity Data for Project-Level Air Quality Analyses," developed a much-needed guide for developing traffic data and forecasts for project-level air quality analyses (see box, at right).

Community Concerns

Among the products from NCHRP 25-25 research on community concerns was the Task 36 final report, *Recurring Community Impacts*, released in 2007. This document offers guidance to professionals and others who conduct community impact assessments on how to identify and assess the cumulative effects of past and future transportation projects.[4]

Task 41, "Implementation of Community and Cultural Resource Commitments," collected and synthesized information on tools used by state DOTs to track commitments made to communities and regulatory agencies related to places, things, and institutions regarded as having cultural or historic value by any group of people.[5] This includes commitments related to Section 106 of the National Historic Preservation Act; the Native American Graves Protection and Repatriation Act; or Section 4(f) of the U.S. DOT Act of 1966, which prohibits U.S. DOT agencies from using publicly owned land unless no alternative exists.

Anticipated for release early this year, Task 114, "Integrating Tribal Expertise into Processes to Identify, Evaluate, and Record Cultural Resources," identified ways to augment typical archeological and archival research methods with tribal methods and expertise as a way for state DOTs and tribal governments to strengthen their tribal consultation practices.[6]

Photo: Minnesota DOT

NCHRP 25-25 Tasks include approaches to air quality issues, including analysis, regulation, and modeling.

[1] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4104
[2] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3311
[3] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4100
[4] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1654
[5] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1659
[6] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4484

In 2019, NCHRP 25-25 Task 96, "Quick Reference Guide for Traffic Modelers for Generating Traffic and Activity Data for Project-Level Air Quality Analyses," was recognized by the American Council of Engineering Companies of New York with a Silver Award in the category of Studies, Research, and Consulting Engineering Services.

To view the Quick Reference Guide, visit https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3971.

Photo: Groveland Media, Flickr

The 100-year-old 3rd Avenue Bridge in Minneapolis, Minnesota, is undergoing renovations with an emphasis on preserving its historic design elements.

Cultural Resources

Cultural resources topics included studies of best practices in evaluating historic resources and the use of programmatic agreements between state DOTs and regulatory agencies.

Several NCHRP 25-25 Tasks have addressed historic bridges. In 2005, the Task 15 final report, *A Context for Common Historic Bridge Types*, was released.[7] This report describes historic factors that shaped the design of bridges from the 1500s to the 1950s. The report also catalogs common truss, arch, girder, and beam designs, explaining the historical significance of each design type.

Task 66, "Best Practices and Lessons Learned on the Preservation and Rehabilitation of Historic Bridges," presented a series of case studies in 2012 highlighting ways to balance historic preservation with safety and bridge function via thoughtful bridge management programs that encourage collaboration between bridge engineers and historians. Task 118, "Context-Sensitive Design Options for Workhorse Bridges in Rural Historic Districts," expanded upon these ideas with targeted guidance on design choices for rural historic contexts and a practitioner guide to adopting a context-sensitive design process tailored to this unique resource.

Environmental Review Processes

From the beginning, applied research on environmental review processes has been a major area of focus for NCHRP 25-25. In 2003, the Task 5 final report, *Causes and Extent of Environmental Delays in Transportation Projects*, offered valuable insights that are still relevant today, as the transportation industry continues to seek to improve transportation project delivery timelines.[8] Programmatic agreements were examined in 2005 in the Task 13 final report, *Agency Use of and Approach to FHWA-Approved Programmatic Agreements*.

As the use of programmatic agreements has expanded, additional Tasks have provided targeted guidance; for example, Task 107, "Section 106 Delegation Programmatic Agreements: Review and Best Practices," was completed in 2019.

Natural Resources

NCHRP 25-25 research on natural resources includes the following studies on water quality:

- Task 35, "Water Quality Analyses for NEPA Documents: Selecting Appropriate Methodologies" (2008);
- Task 53, "Stormwater Treatment with Vegetated Buffers" (2009);
- Task 101, "Stormwater Monitoring Program Goals, Objectives, and Protocols for State Departments of Transportation" (2017); and
- Task 119, "Enhancing the International Stormwater Best Management Practice (BMP) Database to Serve as a Highway-Specific BMP Database" (2019).

[7] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1288

[8] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1543

Research into road ecology conducted in NCHRP 25-25 includes Task 113, "Road Passages and Barriers for Small Terrestrial Wildlife: Summary and Repository of Design Examples."[9] In 2019, researchers developed an extensive collection of design examples, case studies, and details on considerations for wildlife crossings and barriers for turtles, salamanders, and other smaller-sized animals. Also completed in 2019, Task 102, "Artificial Bat Roost Mitigation Designs and Standardized Monitoring Criteria," developed a manual of BMPs for addressing the habitat needs of bats, explaining the basics of bat ecology and how bridges and other transportation structures can be designed and managed to support bat populations.[10]

Cross-cutting topics include Task 105, "A Guidebook for Communications Between Transportation and Public Health Communities"; Task 17, "Assessment of Greenhouse Gas Analysis Techniques for Transportation Projects"; and Task 32, "Linking Environmental Resource and Transportation Planning: The Current State of Practice."[11–13]

Taken together, the NCHRP 25-25 Tasks offer a rich compendium of practice in a wide range of environmental topics. The reports provide insights into early responses to regulatory changes as well as later reviews to identify practices that have stood the test of time. Although specific regulations may change over time, the NCHRP 25-25 Task reports are resources that will continue to be of value to environmental practitioners seeking analysis methods, decision-support tools, monitoring techniques, and process improvements to support their environmental stewardship efforts.

For a full list of Tasks, please visit https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=761.

Comments on NCHRP 25-25

"The peer exchange under Task 99, 'Lessons Learned from State DOT NEPA Assumption,' was very successful in encouraging productive dialogue between states with NEPA assignment, states considering NEPA assignment, and FHWA headquarters."

—Leo Tidd, WSP

"Most recently, I have found Task 72 ('Current Practices to Address Construction Vibration and Potential Effects to Historic Buildings Adjacent to Transportation Projects') very useful in providing a process to monitor vibration from reconstruction projects that could affect historic buildings and districts."

—Valerie J. Barbie, North Dakota DOT

"NCHRP 25-25 was a great tool for transportation and environmental professionals because of the quick turn-around and practitioner focus. Serving on a 25-25 Task panel was also my first introduction to TRB and NCHRP, for which I am grateful."

— Tim Sexton, Minnesota DOT

Photo: Eric Fischer, Flickr

A bioswale collects stormwater runoff in Washington, D.C. Stormwater management, including vegetated buffers like this one, are a focus of NCHRP 25-25.

[9] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4337
[10] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4098
[11] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4101
[12] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1549
[13] https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1304

Who Is Riding TNCs, and Where Are They Going?

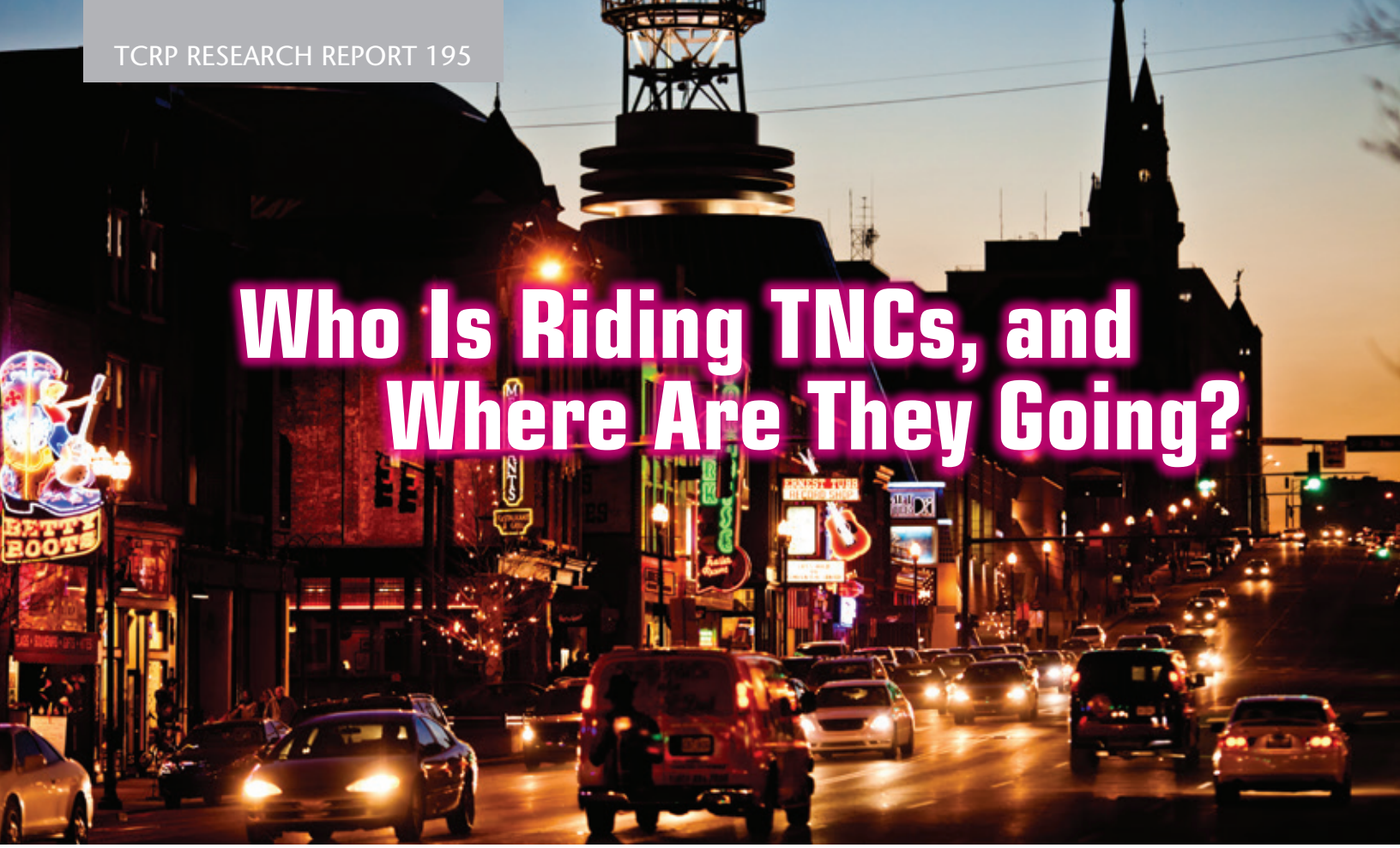

Photo: Thomas Hawk, Flickr

COLIN MURPHY

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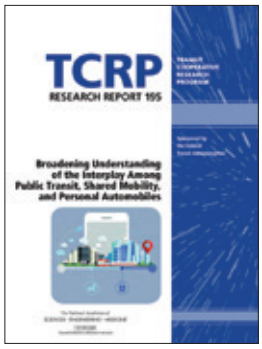
In early 2018, TRB released *TCRP Research Report 195: Broadening the Understanding of the Interplay Among Public Transit, Shared Mobility, and Personal Automobiles*. The report featured one of the first uses of origin–destination trip data directly provided by a transportation network company (TNC); that is, a company that provides urban ride-hailing services, such as Lyft or Uber.

The mobility landscape has evolved rapidly since the report was written, and subsequent work by other researchers has expanded on many of its initial findings.



TCRP Research Report 195 can be found at www.trb.org/Publications/Blurbs/177112.aspx.

The publication of open data on TNC usage by regulatory authorities in a few cities (most notably, New York and Chicago) has also helped fill the gaps in knowledge about how TNCs work and where people ride them, at least in the largest and densest cities. The picture is still murky, however, and *TCRP Research Report 195* remains a key source of information on how TNCs are used in a variety of urban settings in the United States.

Study Sources and Regions

The study's centerpiece was the examination of TNC trip data provided by one of the major national TNCs in indexed form (with the number of rides between location pair converted to a 0–100 scale), aggregated to the zip code level. The data contained trips originating in the central counties of the metro areas of Chicago, Los Angeles, Nashville, Seattle, and Washington, D.C., during May 2016.

The researchers also surveyed more than 10,000 transit and shared mobility users nationwide, in what is referred to

Above: Nashville, Tennessee. More trips in transportation network company (TNC) vehicles are taken on Friday and Saturday nights than at any other time or day.

Photo: Jeffrey Zeldman, Flickr

In Chicago, data showed heaviest peak-hour TNC use in the downtown Loop—even though the area is well-served by transit.

here as the "Shared Mobility Survey." They also incorporated data from surveys about TNC use that were administered to riders by four large public transit agencies, called here the "Four-Agency Survey."[1]

The full methodology and findings of these data sources, as well as detailed breakdowns of the data for each of the study regions, is described in the report and its appendixes, available for download from the National Academies Press. The full report also includes recommendations for how transit agencies of various sizes can engage with TNCs most productively. This article offers an abbreviated version of the study's most important findings.

When TNC Trips Take Place

Evening hours and weekends see the heaviest use of TNCs, followed by weekday peak-hour travel. TNC trip data across the study regions, as well as surveys by the researchers and cooperating transit agencies, showed that the greatest levels of TNC use occurred on Friday and Saturday evenings.

Figure 1 (below) shows relative TNC trip volume by hour across the week. In all the study cities, the single busiest hours fall on Saturday nights at 9 or 10 p.m., and the lowest-volume hours uniformly fall on early weekday mornings. Friday and Saturday together account for 38–45% of TNC trips in the study regions, while all weekday peak hours combined comprise only 20–27% of trips.

Where TNC Trips Take Place

CONCENTRATED IN DOWNTOWN AREAS

Though evening "party time" dominates the temporal distribution of trips, peak-hour usage still is an important factor. At the traditional commute times, most TNC trips happen within and among just a few areas in the densest cores of the study regions—with airport trips a notable exception.

An examination of peak-hour TNC patterns in the metropolitan areas of Chicago and Washington, D.C.—the study regions with the greatest peak-hour TNC usage—shows that activity is concentrated in the urban cores, along short corridors between dense neighborhoods, and in dense core-adjacent suburbs. In Washington, D.C., these areas fall along an East–West belt across the central section of the District, from

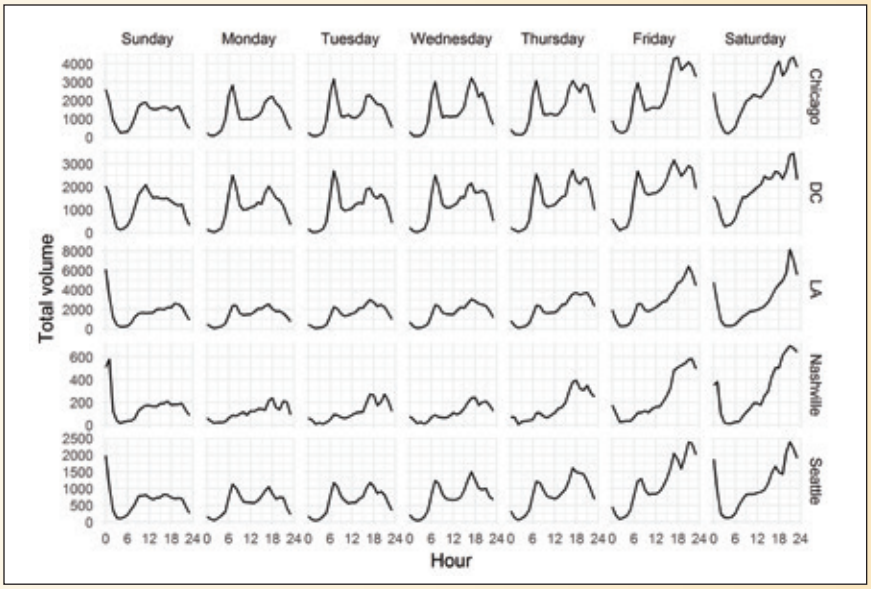


FIGURE 1 Total TNC trip volume (*left*) in the five study regions (*right*), by hour (*bottom*) and day of the week (*top*). (Note: Trip volumes are relative, derived from normalized, aggregated figures provided to the researchers. Source: TNC trip data.)

[1] The transit rider surveys were administered in 2015 by the Metropolitan Atlanta Rapid Transit Authority in Atlanta; New Jersey Transit in the state of New Jersey; Bay Area Rapid Transit in the San Francisco Bay Area of California; and Washington Metropolitan Area Transit Authority in the Washington, D.C., region.

Photo: Kevin Oliver, Flickr

Analysis of TNC use in Washington, D.C., showed the highest use in dense neighborhoods like Georgetown.

the Arboretum area to Georgetown and across the Potomac to Arlington, Virginia (see Figure 2, below).

In Chicago, the heaviest peak-hour TNC trips take place in the downtown Loop or in dense neighborhoods to the north and northwest, with an outlying area of high usage in Evanston (Figure 3, at right). Like Arlington, Evanston is a walkable, transit-connected suburb bordering the city.

All these high-usage areas are well served by public transit. Although the areas include many of the highest-income downtown residential areas in their respective regions, sizeable swaths of lower-income neighborhoods fall within these zones as well.

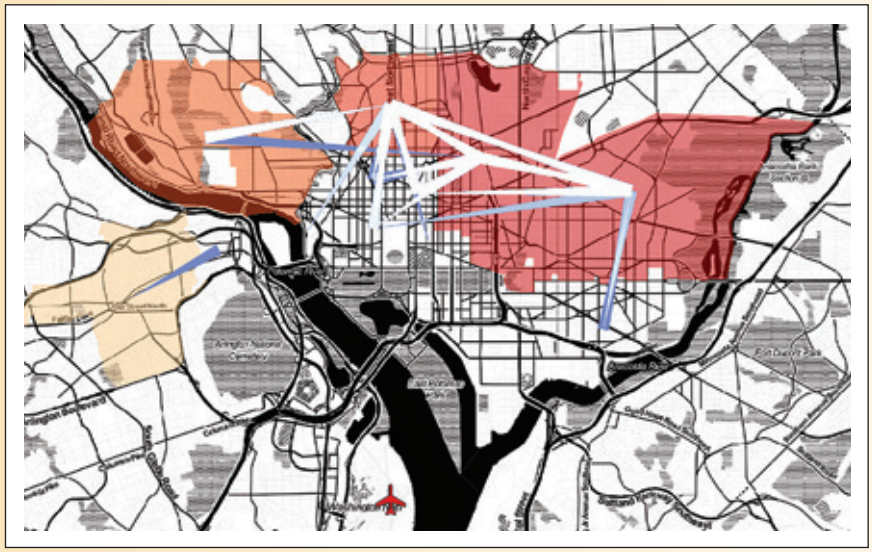


FIGURE 2 Major peak-hour flows in the Washington, D.C., region. Arrows show flows between zip codes (brighter = greater volume) and colored areas indicate zip codes with internal single-zip flows (darker = greater volume). (Note: "Major" refers to hourly volume greater than 25% of the highest volume flow for the region. Source: TNC trip data.)

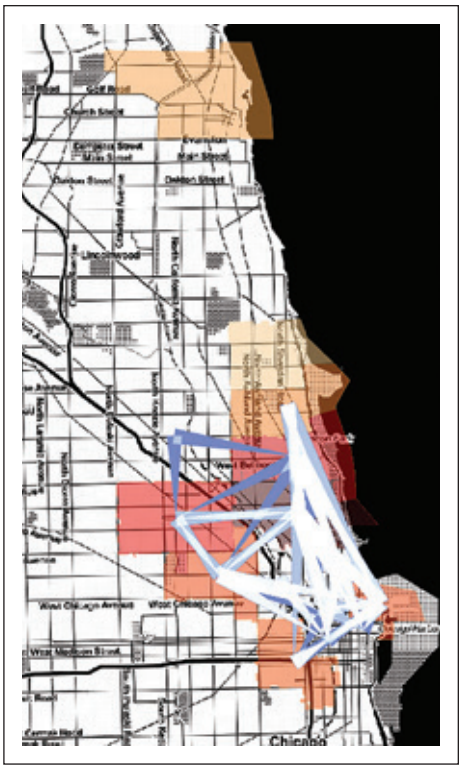


FIGURE 3 Major peak-hour flows in the Chicago. Arrows show flows between zip codes (brighter = greater volume) and colored areas indicate zip codes with internal single-zip flows (darker = greater volume). (Source: TNC trip data.)

ACROSS INCOME LEVELS

Communities of all income levels see TNC usage. Individual trips are widespread across the study regions, suggesting that TNCs are used by people in communities across the socioeconomic spectrum. Almost every zip code in the study regions' core counties serve as ride origins, and ride destinations cover an even wider area (Table 1, page 35). At least two-thirds of zip codes in every region have trips originating in them. More than half of the zips have "significant flows;" that is, TNC flows for which a relative volume can be calculated, which is limited because of obfuscation of the data at the low end by their provider.

Destination zips cover an even wider part of the five regions. Nearly every zip code in the study regions shows at least some TNC trips both starting and ending there. A map of trip origins in the Los Angeles region, typical of their

TABLE 1 Number of Unique Zip Codes with Actual and Significant Flows

REGION	ORIGIN ZCTAs WITH FLOWS (%)	ORIGIN ZCTAs WITH SIGNIFICANT FLOWS (%)	UNIQUE DESTINATION ZCTAs
Chicago	90	51	311
Washington, D.C.	69	68	336
Los Angeles	86	81	547
Nashville	86	78	61
Seattle	82	81	135

NOTE: ZCTA = zip code tabulation areas.
SOURCE: TNC trip data.

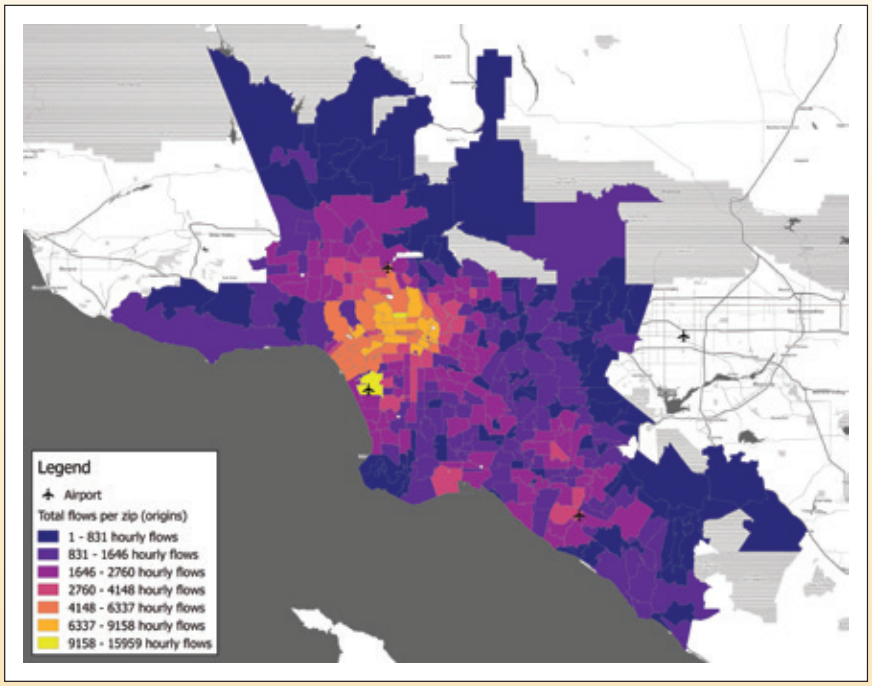


FIGURE 4 TNC trip origins by zip code, Los Angeles region. (Source: TNC trip data.)

distribution patterns elsewhere, is shown in Figure 4 (above).

CORE AREAS AND AIRPORTS

Over all, the highest levels of TNC use are concentrated in core areas and near airports. Despite the breadth of trip-making activity in each of the study regions, TNC use appears to occur at a fairly low level across most of the metropolitan areas, with most activity limited to certain areas.

A plurality of trips take place within just a few core areas: as with peak hours, the highest volume of trips overall generally fall within a single zip code, between nearby zip codes, or to or from an airport. The top five zips in each region account for one- to three-quarters of the total flows count.[2]

[2] "Volume" refers to the aggregated TNC volume index for all hourly zip code pairs for which these numbers are provided; that is, only those with a volume index greater than 2%. "Flow count" refers to a simple count of all hourly zip code pairs; that is, all nonzero flows, regardless of whether a volume index is provided for a given hour.

Trip Lengths

SHORT TRIPS DOMINATE USAGE

The range of TNC trip lengths for every hour of the week is shown in Figure 5 (page 36). In that figure, the vertical lines show the central 50% of trip distances for each hour, centered on a gap representing the median, with points above and below the lines indicating the maximum and minimum, respectively.

Across the five study regions, the median TNC trip length varies between 2.2 and 3.1 miles, with the shortest trips in Washington, D.C., and the longest in Nashville. Maximum trip lengths range between about 20 and 30 miles.[3]

REGIONS VARY

Although the bulk of TNC trips are short, regions vary in typical trip lengths by hour and day. Chicago, Los Angeles, and Seattle all show peaks in trip lengths in the early morning hours (between 2 and 5 a.m.), meaning that longer trips make up a greater proportion of trips at those times. In Chicago and Seattle, the median trip in this period often is longer than 10 miles. This pattern likely reflects a large proportion of airport trips as well as the general unavailability of frequent public transit at these times.

Very short journeys (within a single zip code) represent a substantial proportion of TNC trips, and though their greatest volume is concentrated, these short trips occur widely across each of the study regions.

In all the study regions, the single top origin–destination flow is *within* a single zip code, and the majority of flows by volume occur within single zips. The proportion of single-zip trips ranges from 14% (Chicago) to 29% (Nashville) of total TNC trip volume (Table 2, page 37).These short trips take place across broad geographies—in at least three-quarters of the zip codes in every region—and at all hours of the day.

[3] The minimum, median, and maximum TNC trip length measurements are based only on TNC flows for which a volume was supplied; that is, those with a volume index greater than 2%.

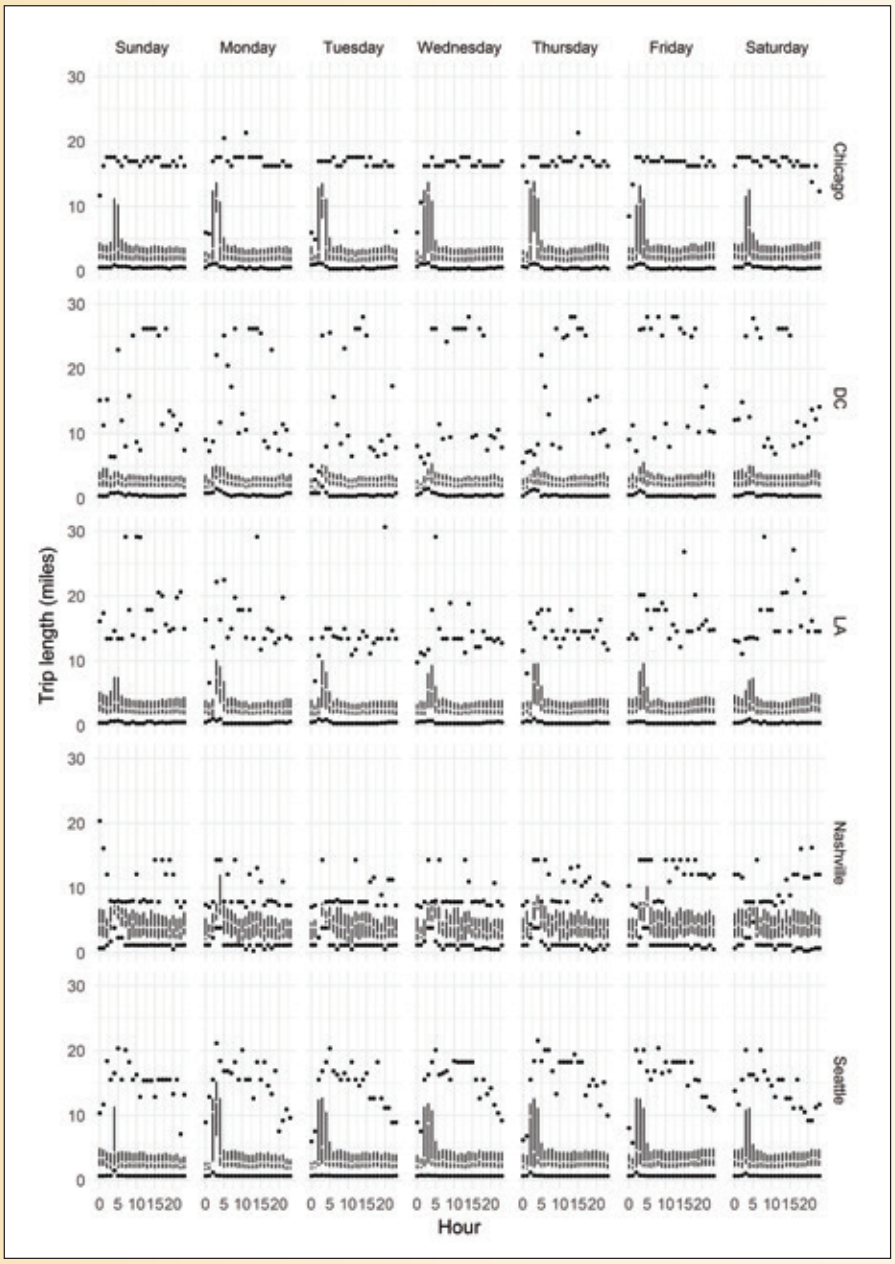


FIGURE 5 Range of TNC trip lengths. For each hour (bottom), vertical lines show the 25th–75th percentiles, with a gap at the median. Points above and below represent maximum and minimum values. (Source: TNC trip data.)

Major Role of Airports

Airports appear to be the major non-core areas of TNC trip activity in almost every study region. The highest-volume TNC trip origins and destinations are found in areas containing major airports; in fact, the zip codes containing Los Angeles International Airport and Reagan National Airport in Washington, D.C., are the first and fifth most frequent destinations in the entire TNC data set.

Reports from cities throughout the United States that track TNC activity at airports show that TNC trips are a large and growing portion of airport ground transportation, including in regions that have rail links to their airports. A 2015 study commissioned by San Francisco and Oakland International Airports found that 22% of respondents who rode TNC to the airports would have used transit before TNCs were permitted; taxicabs comprised 50% of the forgone uses and private vehicles, 18% (*1*).

Who Uses TNCs

Some insights into TNC riders can be derived from the demographic characteristics of the areas of highest usage, on the assumption that one side or the other of many trips includes TNC users' homes. Zip codes with the highest TNC use are younger, more affluent, more densely populated, and have fewer personal vehicles and more non-car commuters. The zip codes with the highest levels of TNC activity in the five studied regions tend to share several characteristics. Compared with typical aspects of the cities in which they are located, most of these zip codes have:

- Higher household income;
- More young residents and more white residents (all five study regions, however, have some high-TNC zip codes with more black or Hispanic residents than the city average, including several that are majority black or Hispanic);
- Greater population density—often 2 to 4 times the city average—and smaller households;
- Fewer vehicles per household, fewer solo-driving commuters, and more transit, walking, or biking commuters; and

TABLE 2 Characteristics of TNC Trips Within a Single Zip Code

REGION	MEAN SINGLE-ZIP TRIP VOLUME AS PROPORTION OF TOTAL TNC TRIP VOLUME (%)	MIN. PROPORTION OF SINGLE-ZIP TRIPS (DAY, HOUR)	MAX. PROPORTION OF SINGLE-ZIP TRIPS (DAY, HOUR)	NUMBER OF ZIP CODES WITH SINGLE-ZIP TRIPS (% OF TOTAL ORIGIN ZIP CODES)
Chicago	14	4% (Mon., 3 a.m.)	41% (Tues., 1 a.m.)	74 (79)
Washington, D.C.	18	7% (Mon., 3 a.m.)	53% (Tues., 2 a.m.)	104 (80)
Los Angeles	20	5% (Weds., 4 a.m.)	41% (Tues., 2 a.m.)	274 (85)
Nashville	29	11% (Tues., 3 a.m.)	70% (Weds., 2 a.m.)	19 (73)
Seattle	15	4% (Tues., 3 a.m.)	26% (Weds., 1 a.m.)	52 (79)

SOURCE: TNC trip data.

- Higher average education levels, with greater proportions of college-educated residents (perhaps related to this, at least five of the zip codes include college campuses).

Use Frequency

Both the Shared Mobility Survey and the Four-Agency Survey suggest that TNCs are used more as a "gap-filling" transportation option and less as a mode for daily commuting or other frequent trips. People who use transit or drive alone do so as part of a routine, while TNCs are used more occasionally.

Although occasional use of TNCs is widespread, frequent use is less common than with other modes (Figure 6, at right). Compared with other modes—particularly transit—a much smaller proportion of *recent* TNC users (people who have used the service in the past three months) report that they are *frequent* TNC users (people who have used it once or more per week).

Nearly four in five respondents who had used transit within the previous three months also reported using transit once or more per week. For solo driving, this proportion was around two-thirds, but only one in four recent TNC users reported a weekly or greater frequency of use.

Among respondents overall, fewer than 10% reported using TNCs weekly or more often (Figure 7, at right). This proportion is in line with other nontransit shared modes, like bikesharing and carsharing. Frequent bus and train use and driving were reported by 25–30% of respondents.

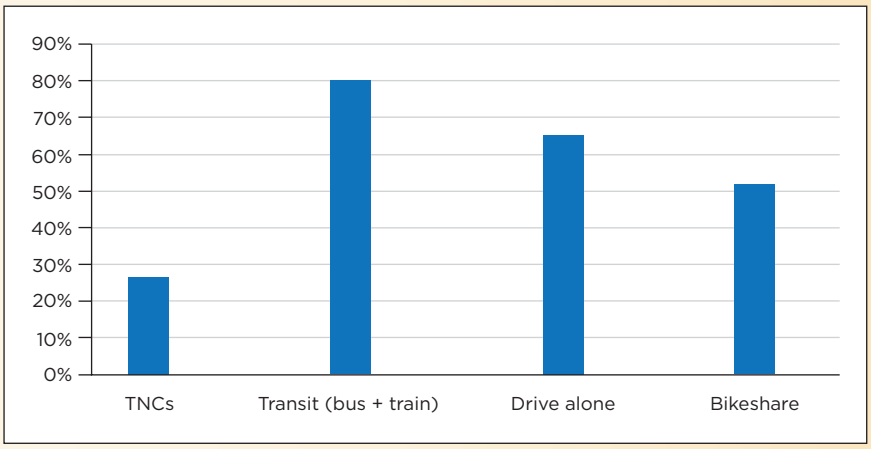


FIGURE 6 Ratio of frequent (weekly or greater) mode use to use within the past three months. (Source: TNC trip data.)

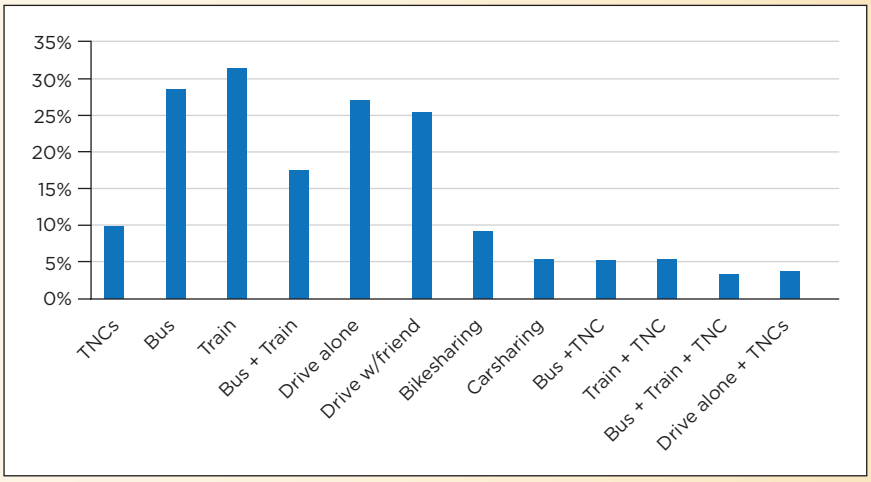


FIGURE 7 Frequent (weekly or greater) use of modes and combinations. (Source: Shared Mobility survey.)

Mode Impact

TNC use is associated with lower vehicle ownership and single-occupancy vehicle trips, but impacts on other modes are varied. Lower-than-average car ownership is associated with both frequent transit and TNC use, and those who combine these modes report the lowest car ownership. In the Shared Mobility Survey, frequent TNC and transit users reported an average of fewer than one household vehicle, compared with an average of 1.2 cars across all respondents (Figure 8, at right). For frequent solo drivers, the household vehicle figure, 1.6, is nearly double that of frequent TNC users.

The lowest car ownership levels were found among respondents who frequently combine two or more nonpersonal auto modes, particularly among frequent users of buses with TNCs and buses and trains with TNCs.

On decisions related to purchasing a car, between 5% and 21% of Four-Agency Survey respondents reported a net reduction in vehicle ownership attributable to TNCs—the combination of postponed purchase, deciding not to purchase, and selling a car without replacement. This outweighed the few people in each region who acquired a car to become a TNC driver.

TNC's broader impacts were beyond the scope of this study. Not addressed were TNCs' net impact on vehicle ownership—for example, among people who are not transit riders or do not use other forms of shared mobility—and on vehicle miles traveled (VMT). Since only existing shared mobility or transit users were contacted for the surveys, the data cannot be interpreted to draw conclusions about impacts and usage changes among the general population outside these groups, nor can VMT impacts be estimated from the aggregated trip data.

Outcomes of TNC use among the broader traveling public, especially outside of major urban areas, remain an important area for future research.

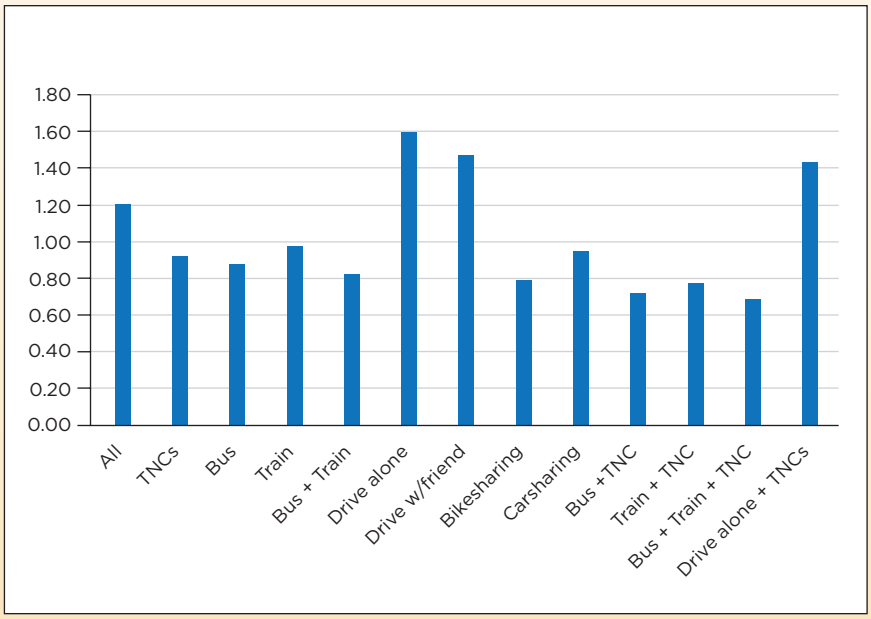


FIGURE 8 Average household vehicles, by frequently used mode (weekly or greater). (Source: Shared Mobility Survey.)

REFERENCE

1. Mandle, P., and S. Box. *ACRP Synthesis Report 84: Transportation Network Companies—Challenges and Opportunities for Airport Operators.* Transportation Research Board, 2017, pp. 29–30. http://dx.doi.org/10.17226/24996.

Training Program for Transportation Research Managers

Photo: GPA Photo Archives, Flickr

CYNTHIA J. SMITH, INES AVILES-SPADONI, AND DAVID M. JARED

Smith is State Research Engineer, Mississippi DOT, Jackson; Aviles-Spadoni is Research Program Coordinator, University of Florida Transportation Institute and Southeastern Transportation Research, Innovation, Development, and Education Center, Gainesville; and Jared previously was Research Section Chief, Georgia DOT, Atlanta, and now is Senior Program Officer, Transportation Research Board, Washington, D.C.

Above: The Ahead of the Curve training program was geared toward the niche area of transportation research management, helping state DOTs, university transportation centers (UTCs), federal agencies, and more to accomplish research management goals.

Megan Swanson, technical research coordinator at the Illinois Department of Transportation (DOT) Bureau of Research, monitors and reviews a bundle of research projects each day—whether recently awarded, ongoing, or nearing completion. She tracks projects for deliverables, technical review, implementable outcomes, and trainings; works with principal investigators and others; and always looks for ways to improve processes.

Swanson, who has managed research projects for more than 5 years, recently completed all the courses in the TRB training program "Ahead of the Curve: Mastering the Management of Transportation Research," or AOTC. The training program, which is nearing the end of its pilot phase, is designed to enhance the knowledge, skills, and abilities of transportation research managers.

"My experience with AOTC was wonderful," Swanson affirms. "I learned something new in each class session, and I would end the classes with pages of notes and ideas from the course content as well as from my fellow students."

Transportation research management is a niche area, so the AOTC training program was geared toward research managers at state DOTs, university transportation centers (UTCs), federal agencies, consulting firms, and industry members and was structured to ensure that the curriculum includes vital information for the successful operation of a research program. Courses are taught by instructors who have many years of transportation research management experience.

Evolution of AOTC

Ahead of the Curve was born out of the need to develop training for state DOT, university, and other research managers in the transportation industry. In 2011, raising the profile and stature of transportation research became a major theme at meetings of the TRB Technical Activities Council and of the TRB standing committees on Conduct of Research and

Photo: Risdon Photography

Mark Norman, then the Technical Activities Division Director, was instrumental in developing the idea for transportation research manager training.

Technology Transfer. It also was a focus of the summer meeting of TRB state representatives and the American Association of State Highway and Transportation Officials (AASHTO) Research Advisory Committee (RAC), which supports the AASHTO Special Committee on Research and Innovation (R&I) as it promotes quality research and application to improve state transportation operations.

It quickly became clear to Mark Norman, who then was TRB's Technical Activities Division Director, that a more formal training of transportation research managers was necessary. He approached Skip Paul, who at the time was Director of the Louisiana Transportation Research Center and RAC chair, for his thoughts. "I immediately jumped at this opportunity, since RAC was gaining new members at the rate of 7 to 13 a year," Paul recalls. "Many of these new research managers had no research background; the AOTC program would provide tremendous benefit in bringing these new members quickly up to speed."

Discussions among TRB staff and volunteers eventually led to an educational training program in 2012. The following year, a working group was formed, comprised of individuals from a cross-section of employers, including academic and research institutions, public agencies, and the private sector. The working group collaborated with TRB staff to provide direction and advice for AOTC. It defined the following objectives:

- Raise the stature of transportation research and innovation managers;
- Ensure high-quality transportation research programs and projects that contribute to transportation goals;
- Better communicate the value of research to those outside of the research community;
- Provide research managers with a sense of belonging to a profession and a sense of pride in serving society; and
- Offer credit to research managers toward professional licenses, certifications, or both.

The AASHTO Standing Committee on Research—which since has been renamed R&I—provided funding through the National Cooperative Highway Research Program (NCHRP). NCHRP Project 20-105, "Development of Course Outlines for the Ahead of the Curve Training Program," was the first of three NCHRP projects using volunteer technical experts to oversee the work of contractor teams to build the entire curriculum.

In 2016, NCHRP Project 20-105(A) provided pilot offerings of the core courses and development of elective course materials. To support the implementation of 20-105(A) products, a TRB joint subcommittee was formed in 2017 under the umbrella of the Transportation Education and Training, Conduct of Research, and Technology Transfer standing committees. NCHRP Project 20-105(B) provided final developmental efforts for coursework, pilot testing, and instructor manuals and materials. Jason Bittner, Applied Research Associates, led the effort to develop and pilot test the courses.

"We've tried to extract the best from research managers in programs at all maturity levels and in varying sizes and staffing levels," Bittner comments. "We think the program is a great opportunity to share and expand knowledge, ensure quality, and raise the stature of transportation research managers in their agencies."

Throughout the course of its conception and development, AOTC has been championed and enhanced by many people experienced in the management

Skip Paul (*center*) participates in the 2013 Standing Committee on Research meeting in Washington, D.C., at which an NCHRP project to develop the AOTC curriculum was funded.

of transportation research. Along with Paul, Norman, and Bittner, these include Barbara Harder; Cynthia Jones and Victoria Beale, Ohio DOT; and James Bryant, TRB. Katie Turnbull, Texas A&M Transportation Institute, worked with Bittner to develop the curriculum, with later assistance from her colleague Johanna Zmud.

Benefits of AOTC

Among the benefits to agencies, universities, and individuals offered by the AOTC program is a sense of belonging to the profession of transportation research management, by standardizing the practice. For university researchers, earning a certificate from AOTC would provide recognition of knowledge of the niche area of transportation research; additionally, AOTC provides an excellent networking opportunity.

The courses present information that elevates the quality of transportation research programs, thus raising the stature of transportation research and innovation. For example, how can a transportation agency ensure that a new manager—perhaps one who has never managed transportation research—has all the necessary tools to be successful in their new role? AOTC can help onboard new research program and project managers more quickly. New and seasoned research managers can enhance their knowledge, skills, and abilities by learning important information about how to make research relevant, how to run a research program, and how to deliver the program and technology transfer—as well as the never-ending task of improving a program via evaluation, monitoring, and performance measurement techniques.

Binh Bui, a research implementation manager at Georgia DOT, recently completed the program along with Swanson. One of the things that Bui found very useful about AOTC is that it creates a space that allows for the exchange of good practices and the standardization of the management of transportation research.

"AOTC enhanced not only my knowledge, skills, and abilities in managing transportation research programs, but also established a national platform designed for our community of practice to share and promote good practices and standards," Bui noted.

Photo: Tom Driggers, Flickr

The AOTC curriculum is useful for UTCs to coordinate research programs on topics like people and goods movement.

The training program can assist in on-boarding new research project managers who are making the transition from technical and engineering work to research or, in some cases, integrating and handling both responsibilities; explaining the entities involved in national research, such as FHWA, AASHTO, and TRB; and working with technical subject-matter experts to move from a research idea to a project.

Other benefits of AOTC include the following:

- Knowledge capture and transfer, helping to stanch "brain drain" and institutional bleeding;
- Building a network, forming partnerships, and joining a robust community of practice;
- Understanding the entire research program and the agency's role in it;
- For staff in smaller agencies, learning how to do more with less, for example, leveraging other funding sources, collaborating with other agencies, and working with national entities;
- Tapping into ideas to maximize their effectiveness, such as funding sources;
- Helping staff to raise profile of the research program, both nationally and at the state level; and
- Providing tools to display the value of research to upper management, champions, and elected officials.

Transportation research managers from the academic sector, specifically those working at University Transportation Centers (UTCs) and transportation research institutes, also can benefit from AOTC. Often considered primary stakeholders and providing a good portion of the cost share requirement for the UTC program, academic research managers frequently interface with state DOTs. These professionals may find that the information contained within the curriculum helps them learn more about the connections between UTCs and state DOTs. Hau Hagedorn, formerly a UTC research manager, is director of the Transportation Research and Education Center at Portland State University. She knows first-hand the challenges that research managers face when learning about the complexities of the job.

"There is a lot that goes into managing research programs efficiently and effectively," Hagedorn observes. "The AOTC course offers directly applicable training that, for many managers, takes

Photo: Paul Krueger

The AOTC curriculum includes vital information for the successful operation of a research program.

years to learn on the job. It synthesizes and organizes information that research managers can use and apply directly after completing the training."

Karen Philbrick, executive director of Mineta Transportation Institute at San Jose State University, believes that the AOTC training program will supply research managers with the knowledge necessary to run an effective research program. AOTC offers verified, creative techniques for research management and implementation as well as essential skills for moving research findings into practice, she comments: "Participants learn best practices for research management and implementation and in doing so help ensure that UTCs play a major role in contributing to a safe, seamless multimodal transportation system."

The last course in the list of electives, Program Design, is a capstone course bringing together the information presented in the training series. At the end of the course, participants will perform an overall evaluation on their program design, Bittner notes: "They will utilize the information to determine how their program can be improved and then develop a plan to implement their new program design." For example, a research manager could complete or revise a state DOT or university research manual, develop or improve a research project tracking system, work on performance metrics, write or update a strategic plan, and initiate or expand research marketing.

How Will the Courses Be Offered?

Most courses will have two delivery options available—web-based and in person—but the creators of the program and the students who took part in the pilot believe the best value lies in the in-person courses, citing group activities and the sharing of best practices. Also valuable is the opportunity to meet other research managers from state DOTs and from the academic and private sectors.

"One benefit of the in-person courses was that they provided a time to meet face-to-face with peers and discuss their programs and experiences," Swanson muses. "Since we were together for the entire day, we had time to dig into non-course-specific issues during our lunches and breaks. It really helped to build and reinforce a feeling of camaraderie among each class group."

AOTC electives will be offered as web-based courses to accommodate students with travel restrictions.

Completing the AOTC Training Program

Students who complete the four core courses and at least four elective courses are awarded a certificate of completion. Although the certificate is not the equivalent of a professional license or certification, it shows a dedication to transportation research and recognizes the participant's hard work.

The first group of AOTC trainees under the pilot program graduated in July 28, 2019, in a ceremony at the AASHTO-RAC

meeting in Santa Fe, New Mexico. Swanson and Bui joined two other colleagues—Susan Sillick, research program manager at Montana DOT, and Tyson Rupnow, associate director of the Louisiana Transportation Research Center.

Rupnow plans to encourage others from his unit to enroll in the training program: "Completing the program felt good. I would recommend AOTC to other DOT personnel who are interested in increasing their knowledge on the research process. The classes actually serve as a sort of a mini–peer exchange in which one can learn from other research programs."

As for Swanson, she is on a never-ending quest to improve her research program at Illinois DOT. By using the information learned in the Performance Measurement elective course, she already is identifying new performance measures to better assess the effectiveness of her program. "I am always looking for ways to hone my skills and make our program more effective," she said. "To me, problem-solving means doing the best I can to get to the root of the problem and identifying the current solution, as well as how we can prevent the issue from recurring in the future. What better way to do that than to participate in these classes created and taught by subject-matter experts?"

Acknowledgments

The authors thank Skip Paul, Mark Norman, Hau Hagedorn, Jason Bittner, and Karen Philbrick for their contributions to this article.

For more information on Ahead of the Curve: Mastering the Management of Transportation Research, contact Ines Aviles-Spadoni at iaviles@ce.ufl.edu or Skip Paul at captskippaul@gmail.com.

The AOTC Curriculum

The curriculum is comprised of four required core courses and 12 electives. Below is a list of the required core courses and descriptions:

1. **Making Research Relevant.** This overview course provides a basic understanding of the importance and value of research, types of research, the research life cycle, and stakeholders that typically are involved in transportation research, for example, state DOTs and universities.
2. **Running a Research Program.** This course presents students with the nuts and bolts of running a transportation research program. Participants will learn about establishing and facilitating oversight committees, soliciting research ideas, managing deliverables, tracking and monitoring the program, working with principal investigators, reviewing proposals, contracting, research results, and dissemination.
3. **Delivering the Program.** This course will provide a basic understanding of technology transfer and methods of delivery, ways to assess the return on investment and performance measurement for research projects and programs, and ways to communicate the benefits of research projects and programs to different stakeholders effectively.
4. **Quality Improvement.** Students will learn about quality assurance, quality control fundamentals, strategic planning to determine what they want to achieve, research program evaluation, project-monitoring practices, and measurement and analysis of stakeholder feedback.

The electives offered include

1. Continuous Quality Improvement,
2. Funding,
3. Knowledge Management,
4. Writing Effective Research Needs Statements,
5. Building and Engaging Effective Research Champions,
6. Building Partnerships,
7. Strategic Planning for Research,
8. Innovation and Risk Management,
9. Intellectual Property,
10. Performance Management,
11. Scientific Methods, and
12. Program Design for Individual Projects.

Collaboration Demonstration

New Jersey Hosts State Partnership Visit

Photo © New Jersey DOT Bureau of Aeronautics

STEFANIE POTAPA, AMANDA GENDEK, AND GLENN STOTT

Potapa is Research Project Manager, Bureau of Research; Gendek is Manager, Bureau of Research; and Stott is Unmanned Aircraft Systems Coordinator, Bureau of Aeronautics, New Jersey Department of Transportation, Trenton.

Above: A UAS flown during the TRB visit to New Jersey DOT captured an aerial image of the Wittpenn Bridge.

Each year, representatives from the Transportation Research Board (TRB) visit with state departments of transportation (DOTs) to strengthen the partnership between TRB and state DOTs, identify current issues, collect and generate information, and disseminate that information throughout the transportation community.

In late February, Christine L. Gerencher and Andrew C. Lemer of TRB traveled through inclement weather from Washington, D.C., to New Jersey to visit with staff from various New Jersey DOT units. They were met by hosts Mike Russo, Assistant DOT Commissioner, and Amanda Gendek, Manager, Bureau of Research (BOR), as well as more than 40 staff members.

Knowledge-Sharing Opportunity

The annual TRB field visit is an important part of BOR's program because it provides a forum for New Jersey DOT staff to share such information as research initiatives, new technologies, best practices, lessons learned, or specific problems they are currently facing. The TRB representatives then can transmit that information back to TRB so that other states, industry members, or educational institutions can benefit from it or use it to help solve the identified problem. The TRB visitors also highlight the Board's range of services to the DOT and help identify potential candidates from New Jersey DOT staff for TRB committees.

Gerencher is a senior program officer at TRB, managing nine committees within the Aviation group and eight committees within the Environmental and Energy Section as well as chairing the editorial board of *TR News*. Lemer is a senior program officer in TRB's National Cooperative Highway Research Program (NCHRP), managing a diverse portfolio of NCHRP-sponsored research projects with a focus on transportation asset management, system performance measurement and management, regional development, and agency information and knowledge management.

Kimbrali Davis and Stefanie Potapa of BOR worked diligently to produce the

Photo courtesy Stefanie Potapa

The annual TRB state visit allowed New Jersey DOT and TRB staff to share knowledge and information on initiatives, issues, and research directions.

Photo courtesy Stefanie Potapa

When using a UAS for inspection, the resident engineer closely follows protocol to operate the camera controls.

two-day event, collaborating with members of the following New Jersey DOT units and subject areas: Environmental Resources, Capital Investment and Development, Aeronautics, the Unmanned Aircraft System (UAS) Program, Local Aid and Economic Development, and Asset Management. The first day of the field visit allowed Gerencher and Lemer to hear presentations from each invited New Jersey DOT unit, followed by a roundtable discussion. These discussions covered challenges, accomplishments, research needs, and New Jersey DOT participation in various TRB committees and subcommittees.

Field Observations

The next day, Shukri Abuhuzeima, Executive Regional Manager, Capital Program Management, presented an overview of the Route 7 Wittpenn Bridge construction project, complete with project-related statistics and background. Glenn Stott, UAS Coordinator, then spoke about the agency's UAS program and briefed the participants on what to expect when they would arrive at the construction site later that morning.

The group then traveled to the construction site, where all individuals were briefed on safety. Stott, UAS pilot Koree Dusenbury, and visual observer Ashley Davis began a UAS flight demonstration to highlight the capabilities of these vehicles in construction project management and bridge inspection applications. For example, using a drone to inspect projects like the Wittpenn Bridge allows inspection personnel to remain safely on the ground rather than being suspended high over a busy waterway. The drone also can move quickly from one area to another, allowing each inspector to view more structure in less time.

Flight Demonstration

The flight began with Davis and Dusenbury conducting a full systems check followed by a detailed briefing of the mission. In his briefing, Dusenbury—a new Federal Aviation Administration–certified UAS pilot in the Bureau of Aeronautics—included current weather conditions, potential hazards, obstructions such as overhead wires, the flight profile, and actions to be taken in the event of an emergency.

The visual observer is the crew's safety person, who keeps a close eye on potential hazards to the mission. The resident engineer is tasked with ensuring the quality of work; traditionally, this person uses tools such as a bucket truck to inspect the bridge. When using a UAS, however, the resident engineer operates the camera controls and can pan, tilt, zoom, and take photos. The strict and professional communication phrases and safety procedures among the remote pilot, visual observer, and resident engineer during the flight demonstrated impressive coordination and commitment to safety. The remote pilot first communicated each movement of the drone—which then was acknowledged by the crew—before making an input into the UAS controller.

Thanks to a large flat-screen television behind the rear seats of the New Jersey DOT Bureau of Aeronautics drone SUV, visitors and staff were able to observe everything on the control screens of the UAS operators and inspectors during the flight, in real time. This arrangement minimizes crew distractions and maximizes the level of detail available for resident engineers and other observers to evaluate. The large screen also displays flight telemetry, such as battery levels, altitude, speed, and camera settings. The inspection camera's optical zoom is capable of 30x magnification, so the drone can safely fly 20 feet away from a bridge and can still zoom in to magnify critical areas needing closer inspection.

Gerencher commented that the format of the visit could be used as a model for other states on how to prepare for annual TRB state partnership visits.

Photo courtesy Stefanie Potapa

TRB senior program officer Christine Gerencher (*left*) and New Jersey DOT UAS pilot Koree Dusenbury (*right*) prepare for the flight demonstration.

Deborah Flint

Greater Toronto Airports Authority

As Los Angeles World Airports (LAWA) CEO, **Deborah Flint** led a high-profile modernization and general operation of one of the busiest and most well-known airports in the world. Earlier this year, the Canadian-born Flint joined the Greater Toronto Airports Authority as President and CEO, overseeing the Toronto Pearson International Airport—including the safety, security, and experience of its passengers and airport workers as well as its airline partners.

"The digital experience of the future has already arrived," Flint observed in a 2019 speech to the Washington Aero Club (WAC). "Real-time, precise information is expected on maps during construction, whether en route or in terminal, to show what has changed from minutes, hours, days, or weeks ago. Wait times for everything are expected—both real-time and predictive. Personalized shopping and preordering, plus food delivery, are the expectation. . . . This is just a part of reality today."

In 1992, Flint began her career at the Port of Oakland in California. In 2010, she became aviation director, primarily responsible for management, business development, and operation of Oakland International Airport. She oversaw the successful delivery of the $480 million Bay Area Rapid Transit Airport Rail project; addressed passenger decline, helping to stabilize and reverse the trend; redesigned Oakland's customer experience; and invested in terminal renovation and hangar development.

As LAWA CEO, Flint managed a multibillion-dollar modernization program of Los Angeles International Airport that improved airport access; updated and renovated all terminals; enhanced airport security; and established innovative retail, food, and beverage operations. This involved managing the largest public works agreements in Los Angeles history: the $5.5 billion Landside Access Modernization Program, or LAMP, which alleviated traffic and congested curbsides via roadway improvements, parking structures, an automated people mover, and a consolidated car rental center.

"We need to push for our airports to be more innovative, sustainable, to be stewards for local communities, to bring the joy and certainty back to air travel, and together get the funding to invest and let our industry shine," Flint observed in her remarks to WAC.

She also ensured a focus on representation and diversity in LAMP, other major projects, and in general operations by creating a Business, Jobs, and Social Responsibility Division at LAWA, developing the HireLAX apprenticeship readiness-training program, and leading a 30% local-hire requirement for all construction projects. Inclusion was a major focus when contracts for the rental car facility and automated people mover were being procured, Flint commented to WAC: "We asked industry to bring the best private sector construction approaches and reliability to the train, [to] think outside the box to future-proof the ConRAC, and [to] create careers and change lives. The private sector made commitments of 30% local hire—not just during construction but for the 30- and 28-year lives of the contracts."

Flint also leads operations at Van Nuys Airport, a general-aviation airport in the City of Los Angeles and part of LAWA. An emphasis on environmental sustainability led to innovations such as installing solar panels that will power the equivalent of 4,000 homes and offering sustainable alternative jet fuels—the first general aviation airport to do so.

Flint has been a Transportation Research Board volunteer since 2006, when she joined the Airport Cooperative Research Program (ACRP) Project Panel on Exercising Command-Level Decision Making for Critical Incidents at Airports. In 2014, she became a member of the ACRP Oversight Committee and, in 2018, its chair. As chair, she identifies the highest-priority projects for each funding year, defines project funding levels, and articulates anticipated research products.

In a 2019 profile in the magazine Global Traveler, Flint shared this advice for aviation professionals: "Be flexible. [You] are likely already flexible individuals, or [you] wouldn't have chosen this field. Be a sponge, open to everything."

K. Larry Head

University of Arizona

K. Larry Head first became acquainted with transportation as a career in a small gas station garage. He gained a lifelong interest in auto repair from the garage owner, a master mechanic who had worked on his own P-51 Mustang fighter jet as a young pilot in World War II. Head enjoyed the challenge of diagnosing a problem and fixing it. When Head attended the University of Arizona and met his future doctoral advisor Donald G. Schultz, he became fascinated with the potential of engineering.

Head went on to earn bachelor's, master's, and Ph.D. degrees in systems engineering from the University of Arizona, focusing on control theory, communications, optimization, probability and statistics, and modeling and simulation. In his graduate work, Head worked to develop a "smart alarm" monitor that could alert anesthesiologists to potential life-threatening conditions in surgical patients.

Head returned to a transportation focus in 1990. While serving as an adjunct assistant professor, he joined a team of faculty that had received funding to develop a new real-time, traffic-adaptive signal control system. "It seemed like a relatively straightforward problem that we could probably solve over the summer," Head recalls. "It has become a career."

In 1992, Head presented his first paper at the Transportation Research Board (TRB) Annual Meeting in Washington, D.C. Inspired by the support from an audience of more than 350, Head realized that there was tremendous interest in the development of adaptive traffic signal control at the Federal Highway Administration (FHWA) and in the research community.

RHODES (Real-time, Hierarchical, Distributed, Effective System) from the University of Arizona was based on the application of modern operations research methods to take advantage of the natural stochastic process of traffic flow. RHODES was then selected as one of several prototypes to be field-tested by FHWA. Head worked closely with startup traffic signal company Gardner Transportation Systems, which had developed software for the new ATC 2070 signal controller that had helped bring RHODES into the field. In 1996, Head joined Gardner Transportation Systems as senior vice president of research and development.

In 2003, Head returned to the University of Arizona as a research professor, inspired by the challenges of research and mindful of how traffic controllers and traffic management systems really worked.

"The future of our profession is dependent on the diversity of our knowledge, experiences, and creativity."

He had worked on a Transit Cooperative Research Program project that found that traditional approaches to transit signal priority might not yield expected or desired benefits and on a National Cooperative Highway Research Program project on traffic signal state transition logic.

In 2004, Head became involved with the emerging vehicle-to-vehicle and vehicle-to-infrastructure (V2I) wireless communications technology. In 2007, Head worked with the Maricopa County Department of Transportation (DOT), Arizona DOT, Arizona State University, and the University of Arizona to build four prototype V2I applications using this new wireless communication technology: traffic signal priority for emergency vehicles, ramp meter priority for emergency vehicles, emergency vehicle roadside alerts, and integration of roadside alerts into the AZ511 traveler information system. Two years later, all four applications were successfully demonstrated in the Maricopa County DOT parking lot.

"The key drivers to the success of the project were the National Transportation Communications for Intelligent Transportation Systems Protocol standards, which allowed us to communicate with signal controllers and ramp meters, and the SAE J2735 message set with dedicated short-range communications (DSRC) wireless devices, which allowed us to send messages from the emergency vehicles to the infrastructure and other equipped vehicles," Head notes.

Head returned to his automotive roots in 2007 when he joined the Defense Advanced Research Projects Agency's Grand Challenge team to develop a self-driving vehicle that could operate in an urban environment. As the project's traffic expert, Head guided the development of the robot's map, mission, and driving direction components.

Later, Head worked on the first live traffic signal control experiment with DSRC and a prototype signal control application at an intersection in Maricopa County. He also has been part of the Connected Vehicle Pooled Fund Multimodal Intelligent Traffic Signal System research project since 2012.

At TRB, Head is a member of the Traffic Signal Systems Committee, which he served as chair from 2006 to 2012, and the Intelligent Transportation Systems Committee. He is a past member of the Freeway Operations Committee.

"The transportation field is undergoing a significant transformation with the emergence of advanced wireless communications, new sensor systems, and cloud and edge computing that will propel the field of traffic control and transportation management into a new professional domain," Head muses. "The future of our profession is dependent on the diversity of our knowledge, experiences, and creativity."

INFLUENCERS

Nikola Ivanov

Ivanov, 36, is Director of Operations at the University of Maryland's Center for Advanced Transportation Technology (CATT) Laboratory.

How did you first become involved in TRB?
In 2003, I was a computer engineering student at the University of Maryland. The CATT Lab had just been established, and I was a part-time software developer there. The directors of the lab sent me off to my first TRB Annual Meeting. Because my background was in computers, they wanted to introduce me to the world of transportation. I've attended every Annual Meeting since 2003.

In 2007, I met my first TRB mentor, Bob Winick, a seasoned TRB veteran. He introduced me to many people and showed me all the ways I could get involved. And then I volunteered for everything. I became a member of a standing committee, chair of a subcommittee, chair of the Operations and Preservation Group Young Members Council (YMC), then chair of YMC.

TRB veterans have gone out of their way to help me and other young professionals figure out and then jump on TRB's many opportunities.

How has TRB informed your career so far?
I fell into transportation domain by chance, pursuing my interests in software and data. And although I kept working in these fields, TRB taught me about transportation and how my software and data expertise could help solve transportation problems. Through TRB, I've met hundreds of brilliant experts, all of whom help me make a difference in people's everyday lives. This network of experts, colleagues, and friends has been critical in my life.

What are your thoughts on the value of research in the transportation field?
TRB lets you both learn about current research and determine future efforts. There are so many opportunities for the world to learn about the latest transportation work—TRB publications, research papers, specialty conferences, webinars, Annual Meeting sessions and workshops, and more. These opportunities bring people together to help save lives, improve quality of life, and protect the environment.

From inside TRB, standing committees, subcommittees, councils, task forces, and National Cooperative Highway Research Program panels offered me the chance to help identify and define new problems. It's extremely exciting to be involved in that process and help make progress toward a better world.

"Transportation Influencers" is a new section in *TR News*, highlighting the journey of young professionals active in TRB. Have someone to nominate? Send an e-mail to TRNews@nas.edu.

MEMBERS ON THE MOVE

Carmen Monroy retired from the Florida Department of Transportation (DOT), where she was a planning director, and is now with Stantec. Monroy serves on a National Cooperative Highway Research Program (NCHRP) project panel on attracting, retaining, and developing the transportation planning workforce.

Ken Polcak retired from Maryland State Highway Administration in November 2019. As senior transportation engineer for acoustics, Polcak served on many NCHRP project panels and was a longtime member of the Standing Committee on Transportation-Related Noise and Vibration.

Leslie Richards, TRB Executive Committee member and past Vice Chair, joined the Southeastern Pennsylvania Transportation Authority as General Manager in January 2020. Before that, she was Pennsylvania's Secretary of Transportation.

In January 2020, **Nanda Srinivasan** was appointed Associate Administrator for Research and Program Development at the National Highway Traffic Safety Administration (NHTSA). A former NCHRP senior program officer, Srinivasan will oversee the development of NHTSA's critical behavioral safety programs.

In May 2019, **Don Streeter** retired from New York State DOT after many years of service. He is highly active in TRB, as past chair of several concrete materials committees and as current chair of the Concrete Materials Section.

In Memoriam

Joseph A. Burns, U.S. Forest Service, died in November 2019. He was a member of the standing committees on Ecology and Transportation and on Geographic Information Science and Applications.

Cyrus F. Parker, North Carolina DOT, died in January 2020. He was chair of the Standing Committee on Resource Conservation and Recovery, member of the Environment and Energy Section Executive Board, and member of the Standing Committee on Geoenvironmental Processes.

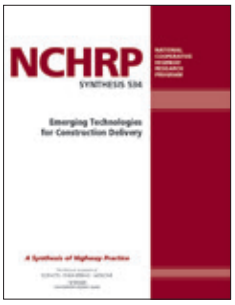
COOPERATIVE RESEARCH PROGRAMS NEWS

Emerging Technologies for Construction Delivery

NCHRP SYNTHESIS 534

New technologies are beginning to change the way state departments of transportation (DOTs) deliver highway construction projects. Relatively new innovations such as 3-D and 4-D modeling, 3-D printing, virtual design and construction, and real-time kinematic GPS can improve project performance cost, schedule, and quality.

The objective of the recently released *National Cooperative Highway Research Program (NCHRP) Synthesis 534: Emerging Technologies for Construction Delivery* was to document the use of selected advanced technologies used for highway construction projects by state DOTs.



The technologies examined include the following:

1. Visualization and modeling,
2. Interconnected technologies,
3. Safety technologies,
4. Instrumentation and sensors, and
5. Unmanned aircraft systems.

Information was gathered through a literature review, a survey of state DOTs, and follow-up interviews with selected agencies for case examples.

Of the 41 state DOTs surveyed, 26 (63%) have implemented visualization and modeling technologies, 18 (44%) have implemented interconnected technologies, 27 (66%) have implemented safety technologies, 31 (76%) have implemented instrumentation and sensors technologies, and 24 (59%) have implemented unmanned aircraft systems for highway construction delivery.

Christofer Harper, Colorado State University; Daniel Tran, University of Kansas; and Ed Jaselskis, North Carolina State University, collected and synthesized the information and wrote the report. To download *NCHRP Synthesis 534*, go to www.trb.org/Publications/Blurbs/179455.aspx.

—Jo Allen Gause
Transportation Research Board

Hendrickson Honored with Lifetime Achievement Award

Chris Hendrickson, member of the TRB Executive Committee and chair of the TRB Division Committee, received the Council of University Transportation Centers–HNTB Lifetime Achievement Award for Transportation Education and Research. The award recognizes individuals with many significant and outstanding contributions to university transportation education and research, resulting in a lasting contribution to transportation, and was presented to Hendrickson on January 11, 2020, in Washington, D.C.

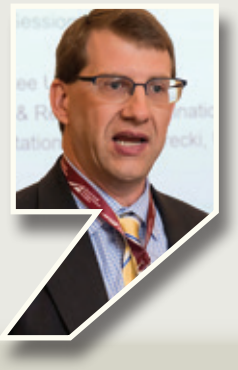
Hendrickson is Hamerschlag University Professor Emeritus and Director of the Traffic 21 Institute at Carnegie Mellon University in Pittsburgh, Pennsylvania. He also is a member of the National Academy of Engineering and editor-in-chief of the *ASCE Journal of Transportation Engineering*.

For more information, see www.trb.org/Main/Blurbs/180136.aspx.

CENTENNIAL QUOTES

"For more than 25 years, I have made treasured and lasting friendships with those I have met through TRB activities. Over the years, as a member of various committees, I have worked closely with industry leaders and have had the fulfilling opportunity to give back to my profession. As a committee chair, I lead an international group of experts that continues to give back to our industry, mentors young professionals, and helps put the "R" in TRB by identifying and developing research problem statements to improve and innovate our transportation system. And it has been a lot of fun too! I attended my first TRB annual meeting as a wide-eyed student in 1993, and I hope to be actively involved in TRB for many more years to come.

—BILL EISELE
Texas A&M Transportation Institute



CALENDAR

March

8–20 Geosynthetics 2020: Case Studies*
Charleston, South Carolina

April

2–3 Commodity Flow Workshop
Washington, D.C.

20–22 Joint Rail Conference*
St. Louis, Missouri

27–30 Transport Research Arena 2020*
Helsinki, Finland

May

18–20 6th International Conference on Roundabouts
Monterey, California

19–21 2nd International Conference on Nanotechnology of Cement and Concrete
Irvine, California

27–29 International Conference on Advances in Materials and Pavement Performance Prediction*
San Antonio, Texas

June

3–6 International Symposium on Pavement, Roadway, and Bridge Life Cycle Assessment 2020*
Sacramento, California

14–17 8th International Conference on Innovations in Travel Modeling
Seattle, Washington

16–18 Advancing the Marine Transportation System Through Automation and Autonomous Technologies: Trends, Applications and Challenges—6th Biennial Marine Transportation System Innovative Science and Technology Conference
Washington, D.C.

22–25 Bridge Engineering Institute International Symposium on Ultrahigh-Performance Concrete and Emerging Concrete*
Singapore

28–July 1 6th International Symposium on Highway Geometric Design*
Amsterdam, the Netherlands

28–July 2 10th International Conference on Bridge Maintenance, Safety, and Management*
Sapporo, Japan

*TRB is cosponsor of the meeting.

RECENT AND UPCOMING WEBINARS

March

5 Quantifying the Performance of Your Pavement Preservation

9 A Conversation on Speed Management

11 Right-Sizing Transportation Investments

16 Making Your Budget Work: Stormwater Management Projects at Airports

17 How Rough Is Your Pavement?

19 Exploring Equity Implications of Emerging Transportation Technologies

26 How to Guide Alternative Contracting Projects

30 Guide for Transportation Performance Management and Data

31 Designing Solid-State Roadway Lighting

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

CONSENSUS AND ADVISORY STUDIES

April

21 Subcommittee on Planning and Policy Review Spring Meeting
Washington, D.C.

28–29 U.S. Coast Guard Maritime Domain Awareness Study Committee Meeting
Washington, D.C.

May

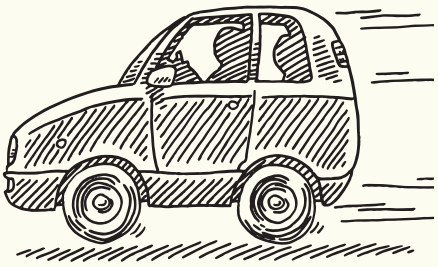
19-20 U.S. Coast Guard Maritime Domain Awareness Study Committee Meeting

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

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.

To subscribe to the TRB E-Newsletter and keep up to date on upcoming activities, go to www.trb.org/Publications/PubsTRBENewsletter.aspx and click on "Subscribe."

COOPERATIVE RESEARCH PROGRAMS

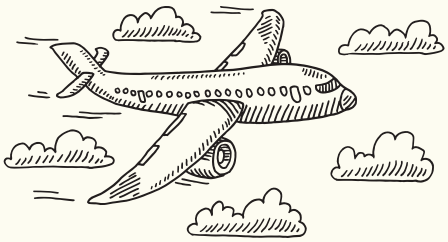


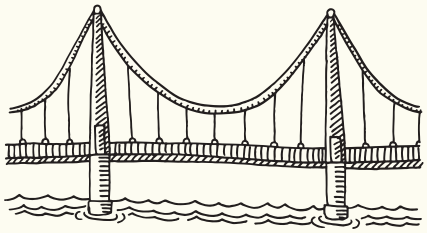
Problem statements are being accepted for the FY2021 Behavioral Traffic Safety Cooperative Research Program and may be submitted by email to btscrp@nas.edu. It is preferred that the problem statement be sent as an attachment to the e-mail message in Microsoft Word format. The deadline for submissions is **Friday, February 21**.

For more information, e-mail Bill Rogers at WRogers@nas.edu.

Airport Cooperative Research Program Synthesis topic ideas are due **Sunday, March 1**.

To submit a topic idea, visit IdeaHub at https://ideahub.trb.org.



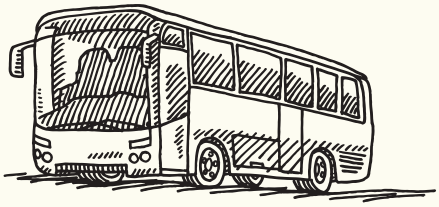


NCHRP Innovations Deserving Exploratory Analysis (IDEA) Program proposals are due **Sunday, March 1**.

For more information, visit www.trb.org/IDEAProgram/IDEAHighway.aspx.

Transit Cooperative Research Program Synthesis topics are due **Wednesday, March 18**.

For more information, visit www.trb.org/SynthesisPrograms/Suggest.aspx.



NATIONAL ACADEMIES EVENTS

March

16–17 **Workshop on Opportunities for Accelerating Scientific Discovery: Realizing the Potential of Advanced and Automated Workflows**
National Academy of Sciences Building, 2101 Constitution Ave NW, Washington, D.C.

For more information, contact Tom Arrison, tarrison@nas.edu.

17 **Building Adaptable and Resilient Supply Chains after Hurricanes Harvey, Irma, and Maria**
MIT Center for Transportation and Logistics, Cambridge, Massachusetts

For more information, contact Steven Stichter, sstichter@nas.

18 **Webinar: Creating Supportive Institutions and Providing Effective Mentorship in Science, Technology, Engineering, Math, and Medicine (STEMM)**
Online

For more information, contact Megan Nicholson, guirr@nas.edu.

TRB PUBLICATIONS

Transportation Research Record 2673
Issue 2

Papers in this issue address topics including adoption of autonomous vehicles for commute trips, classification of air route intersections in the airspace of China, and the impact of traffic volume on pavement macrotexture and skid resistance long-term performance.

2019; 822 pp. For more information, visit http://journals.sagepub.com/home/trr.

Transportation Research Record 2673
Issue 3

An analysis of success plans and performance measures for rural transit systems in North Carolina, a safety evaluation of freight intermodal connectors in Tennessee, and performance evaluation of an innovative high-friction surface treatment are among the papers presented in this volume.

2019; 742 pp. For more information, visit http://journals.sagepub.com/home/trr.

Transportation Research Record 2673
Issue 4

Authors present research on such topics as cyclist safety in London, the use of aerial lidar in measuring streetscape and street trees, the influence of environmental beliefs and safety concerns in gender and rail transit use, and the implementation of AASHTOWare Pavement-ME design software for asphalt pavements in Kansas.

2019; 1034 pp. For more information, visit http://journals.sagepub.com/home/trr.

Approaches for Determining and Complying with TMDL Requirements Related to Roadway Stormwater Runoff
NCHRP Research Report 918

Methods provided in this report for complying with total maximum daily load (TMDL) requirements provide an approach for determining pollutants of concern and how to assess the contribution of the roadway while understanding other factors, including adjacent land use and watershed conditions.

2019; 144 pp.; TRB affiliates, $60; nonaffiliates, $80. Subscriber category: environment.

Field Verification of Proposed Changes to the AASHTO R 30 Procedures for Laboratory Conditioning of Asphalt Mixtures
NCHRP Research Report 919

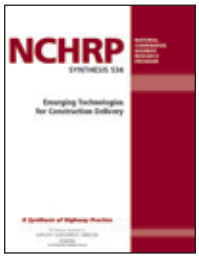
This report offers research on how the decades-old American Association of State Highway and Transportation Officials (AASHTO) R 30 recommended long-term oven aging procedures are no longer realistic and provides consideration for a new procedure for testing asphalt mixtures.

2019; 46 pp.; TRB affiliates, $42.75; nonaffiliates, $57. Subscriber category: materials.

Management and Use of Data for Transportation Performance Management: Guide for Practitioners
NCHRP Research Report 920

Practical guidance is presented in this report to help transportation agencies improve their use of data for performance management. Six life-cycle stages are examined. Included are checklists to identify opportunities for improvement.

2019; 148 pp.; TRB affiliates, $63.75; nonaffiliates, $85. Subscriber categories: highways, data and information technology.



Emerging Technologies for Construction Delivery
NCHRP Synthesis 534

The uses of visualization and modeling, interconnected technologies, safety technologies, instrumentation and sensors, and unmanned aircraft systems in transportation highway construction projects are documented in this synthesis report.

2019; 103 pp.; TRB affiliates, $54; nonaffiliates, $72. Subscriber categories: highways, maintenance and preservation, pavements.

Bridge Demolition Practices
NCHRP Synthesis 536

Examined in this synthesis are practices used by bridge owners to manage and administer bridge demolition in construction projects with the intention of reducing risks associated.

2019; 92 pp.; TRB affiliates, $54; nonaffiliates, $72. Subscriber categories: bridges and other structures, construction.

Revolving Funds for Sustainability Projects at Airports
ACRP Research Report 205

This report provides guidance on the innovative green revolving funds (GRF) approach, offers help for airports to determine if this is suitable, and includes instructions on how to deploy a GRF approach.

2019; 134 pp. Subscriber categories: aviation, environment, finance.

Guidebook on Effective Land Use Compatibility Planning Strategies for General Aviation Airports
ACRP Research Report 206

This report helps airport operators identify various tools for ensuring compatible land use and how to best communicate land use compatibility needs to government decision makers and stakeholders. Included are checklists and an accompanying planning brochure.

2019; 152 pp.; TRB affiliates, $63.75; nonaffiliates, $85. Subscriber categories: aviation, planning and forecasting.

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.

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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.

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- 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.

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