

TR NEWS

March–April 2022

NUMBER 338

Missing and Murdered Indigenous Women

How Can Transportation Stop Traffickers?

PLUS

The 101st TRB Annual Meeting

Evaluating the Airport Traveler's Perspective

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Margo Hill

Social injustices and constraints have left Native American women and girls vulnerable to exploitation and tragedy, and each year—because of human trafficking—thousands go missing, are murdered, or both. The author explains how—by its very nature—trafficking involves transportation and suggests ways the industry can address the problem.

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Kristen Joyner

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Innovating an Equitable, Resilient, Sustainable, and Safe Transportation System

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Patricia Ryan and Komal Sood

Travel—especially airport travel—can be stressful. Ensuring positive interactions throughout the airport terminal starts with an understanding of what customers need and what matters to them most. The authors examine the factors that influence customers, from employees they interact with to the environment itself.



26 NCHRP RESEARCH REPORT 968 Does LED Roadway Lighting Affect Driver Sleep Health?

Rajaram Bhagavathula

Rise and shine? Or can't keep your eyes open? Both responses are influenced by a complex process that starts with the light—or lack of light—that enters our eyes, coming in contact with their intrinsically photosensitive retinal ganglion cells. The author describes research that led to illuminating conclusions on roadway LED lighting and consumer electronics.

32 TCRP SYNTHESIS 152 Working Together to Improve Bus Stops

Todd Hansen

Providing well-maintained bus stops and pathways to them may seem straightforward, but often this is complicated by jurisdictional and right-of-way issues. The study team identified persistent issues and solutions—especially those based on relationship building—that can help transit agencies work effectively with other organizations to better benefit riders and increase ridership.



COVER Red dresses hang empty, gaunt and lonely reminders of the countless Indigenous women and girls who have gone missing or been murdered—many lost to human trafficking and with little accountability. The very nature of the crime relies on transportation. And growing attention drawn to the problem has moved the transportation industry to work to solve it. (Art installation by Jaime Black. Photo: National Museum of the American Indian)

Coming Next Issue

The theme of the May–June 2022 issue of *TR News* features pavement preservation, maintenance, and rehabilitation. Authors examine separate studies on the use of flexible and rigid pavement and how costs and emissions can be reduced with the successful implementation of preservation and maintenance practices.

A Washington State Department of Transportation (DOT) crew performs grind and fill operations to remove cracks and worn sections along US 12 near Gleed. When approached with efficiency and sustainability, such maintenance and preservation projects save money and decrease emissions.



Photo: Washington State DOT

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Where Speed Limits and Safety Intersect

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Since the 1960s, the speed limit has commonly been set at a street's 85th percentile operating speed—that is, the speed of the third fastest driver out of 20. However, this status quo speed limit setting approach contributes to thousands of deaths on U.S. roads every year. The author offers her perspective.

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TR NEWS

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

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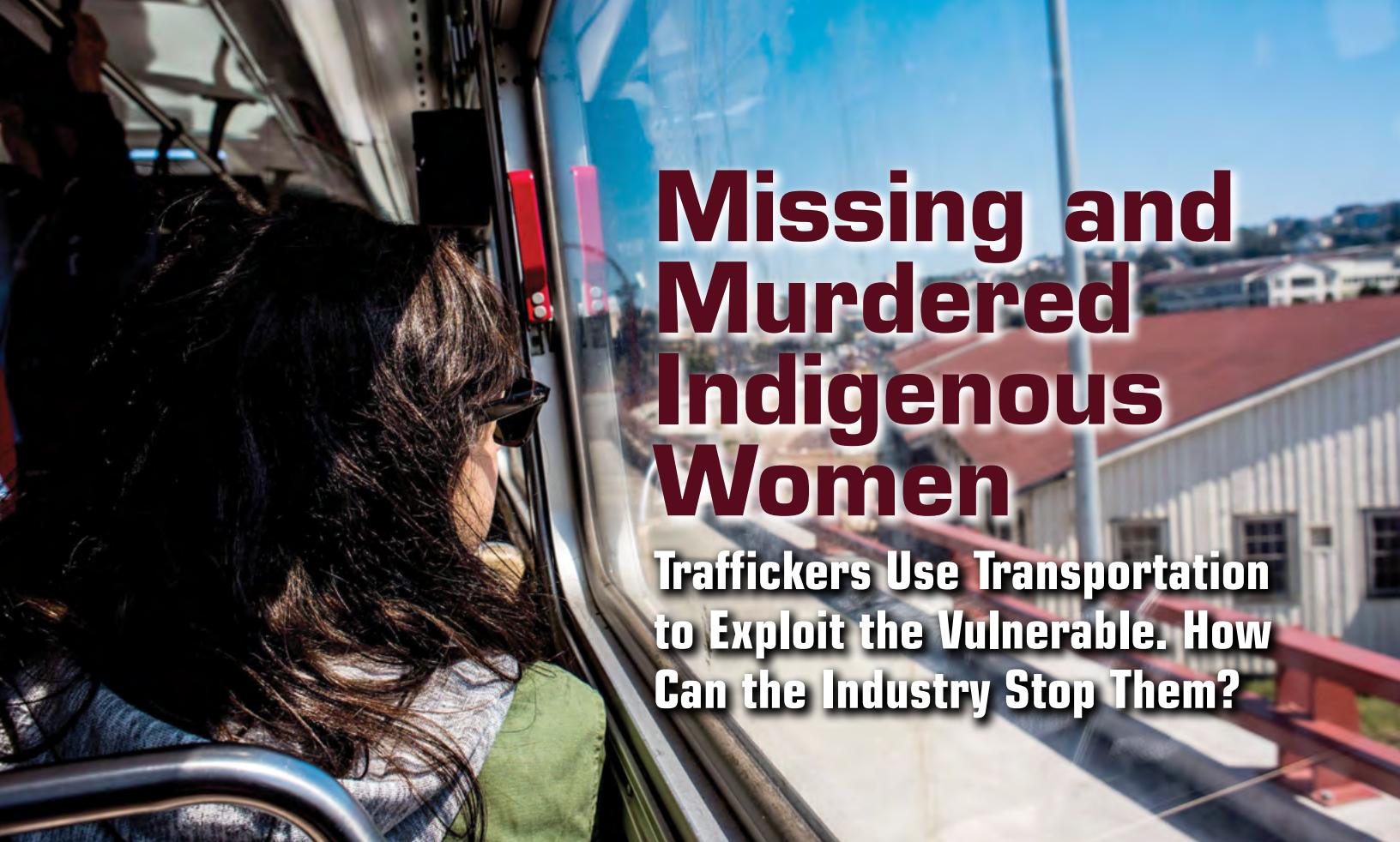
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Missing and Murdered Indigenous Women

Traffickers Use Transportation to Exploit the Vulnerable. How Can the Industry Stop Them?

Photo: Panos Lambrakis, Alamy Stock Photo

MARGO HILL

The author is an associate professor of Urban and Regional Planning at Eastern Washington University in Spokane. She also is associate director of the Small Urban, Rural, and Tribal Center on Mobility; a former attorney for the Spokane Tribe of Indians; and a Spokane tribal member.

Above: What should be a casual bus ride too often ends in tragedy for Native American women and girls, who go missing or are murdered in numbers that are significantly inconsistent among reporting agencies. What role does transportation play in the trafficking that leads to this national crisis? And how can the transportation industry incorporate measures that help combat it?

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No longer will our women be taken, and they are not forgotten!

Patsy Whitefoot, a Yakama tribal elder whose sister is missing, made a simple and heartfelt request during the Oregon State Legislative 2020 session: Rather than quote statistics, begin discussions about missing and murdered Indigenous people with a statement that honors and respects their lives. That is what the Spokane Salish statement that leads this article aspires to do in honor of these missing or murdered Indigenous women and girls, who are real people—someone's daughters, sisters, mothers, and wives. And it is what Whitefoot achieved in her efforts to pass legislation, where she paraphrased the 2007 *United Nations Declaration on the Rights of Indigenous Peoples*:

"Indigenous peoples have suffered from historic injustices as a result of

colonization and dispossession of their lands, territories, and resources. We must recognize and reaffirm that Indigenous individuals are entitled—without discrimination—to all human rights and possess collective rights, which are indispensable for their existence, well being, and integral development as peoples. Indigenous individuals have the right to life, physical and mental integrity, liberty, and security of person."

Deep-Seated Vulnerabilities

Why are Indigenous and Native women and girls so vulnerable? Generational trauma from colonization—or the soul wound—is at the core of most of the significant ailments affecting Native Americans,



Photo courtesy of the National Museum of the American Indian

Outfitted in western finery, the Thomas Indian School Class of 1912 sits for a portrait. Originally an Iroquois, New York, asylum for orphaned and disadvantaged Native American children, the school was eventually taken over by a New York State charity charged with educating and providing vocational training. Those efforts translated into acculturation and assimilation of Native children, which denied them of their traditional culture and prohibited them from speaking their native language. The result is a “soul wound” that many Indigenous people still struggle to heal.

including substance abuse, broken homes, high levels of domestic and sexual abuse, juvenile delinquency, and deep internalized pain. This history of trauma for Native women and girls makes them susceptible to human trafficking and other violence. With the loss of land, culture, language, and identity, tribal communities face limited opportunities for education, jobs, and housing. Native women and girls are more likely to struggle with poverty, violence, and addiction than non-Native women (1). Discrimination is enabled through legal processes, institutional policies, cultural misrepresentations, and limited resources. With restricted funds, tribal law enforcement is stretched thin, and tribal communities lose many officers to better-paying jobs with county law enforcement.

Studies show that American Indians and Alaska Natives experience much higher victimization rates than the rest of the U.S. population. In 2016, *United States v. Lamott* noted that American Indian women are 2.5 times more likely than the national average to experience certain violent crimes, such as nonfatal strangulation. Thus, it is important for

Indigenous women disappear three times: first, when they go missing; second, when the media does not report it; and third, when the data are not reported.

the criminal justice system and social service personnel who respond to crime in tribal communities—as well as transportation professionals—to know the types and frequency of abuse perpetrated on Indigenous women. Such violence includes physical assault, rape, and being threatened with a gun, knife, or other weapon, which results in broken jaws, fractured cheekbones, missing teeth, punched lips, black eyes, hearing loss, memory loss, and neck problems (2). The National Intimate Partner

and Sexual Violence Survey found that four in five American Indian and Alaska Native women (84.3 percent) have experienced violence at some point in their lives (3). This includes 56.1 percent who have been sexually assaulted, 55.5 percent who have suffered physical violence by an intimate partner, 48.8 percent who have been stalked, and 66.4 percent who have been exposed to psychological aggression by an intimate partner (4). The survey also found that one-third of all American Indian women will be raped in their lifetimes (3).

A 2018 report by the Urban Indian Health Institute stated that more than 95 percent of cases involving missing and murdered Indigenous women were never covered by the media (5). Unfortunately, Indigenous women disappear three times: first, when they go missing; second, when the media does not report it; and third, when the data are not reported. The 2021 media outcry over the disappearance of Gabrielle Petito brought such uneven coverage to the forefront (6). When the media *does* report on such cases involving Indigenous victims, many Native Americans view it as depicting them in a negative light, spotlighting their personal and criminal history. These portrayals create vulnerability by perpetuating stereotypes and making excuses for the perpetrator. These images feed into the historical cowboys and Indians mischaracterizations that portray an Indian woman as a sexy Pocahontas in a one-strap dress, promiscuous and unrestrained. That is in stark contrast to actual traditional tribal regalia, in which the majority of women in most tribes are covered from neck to ankles.

Vulnerability also comes from relying on cash systems because, generally, banks are not available on the reservations, and tribal people seldom have credit cards. This makes it difficult to buy bus or rail tickets or to pay for hotel rooms. Running out of cash can leave women stranded. Moreover, tribal people do not always carry the state identification that many transportation services require; instead, they carry tribal identification, which may not be widely recognized or accepted and becomes a further hindrance to purchasing travel fare and paying for lodging.



Photo: Pxhere

Possibly a member of the Wasco people along the Columbia River, a woman wears the modest traditional tribal attire of many Indigenous American women and girls.

Tribal culture requires that Native Americans travel from rural tribal territories to the reservation and longhouse to participate in social activities and ceremonies. With limited access to cars—and few, if any, auto mechanics in rural reservation communities—Native women and girls resort to hitchhiking, which places them at risk. The forms of travel for tribal people are sometimes affected by a lack of access to reliable mode choices provided by the tribal transportation agencies, such as public buses and other ride-sharing and transit for rural communities.

Where Transportation and Trafficking Collide

Mobility investments help people travel freely, and transportation planners focus their efforts on the efficient movement of people and goods. Although women tend to use public transit more than men, the transportation industry has largely failed to institute safety improvements that address threats against women.

"I DON'T FEEL SAFE"

Traffickers use public transit systems every day, taking advantage of safety inefficiencies to seek victims and transport them for prostitution work.

A recent study on adult female transit riders in Los Angeles, California, found that—among LA Metro customers—more women live in poverty than adult male riders. And women are more likely to live in households with one car or none at all, which increases their need for public transit (7). The largest barrier to women riding transit in the LA metropolitan area is that they "don't feel safe." Women who participated in the study suggested stationing transit police nearby and improving lighting to make them feel more secure.

TRAFFICKING HOTSPOTS

Human trafficking of American Indians and Alaska Natives are serious and significant problems. Trafficking in Indian Country includes many elements of transportation that move people and cargo: truck stops, airports, bus terminals, seaports, and borders. For example, the *United States Attorneys' Bulletin*, a former publication of the U.S. Department of Justice, published articles about Indigenous women being taken, held, and sexually abused in the

cargo storage compartments of international ships anchored at the Port of Duluth in Minnesota (8). However, since September 11, 2001—when terrorists targeted the United States—the port has increased security because of its designation as an international point of entry. Credentials and identification are now required to get onto the docks and boats; civilians are not permitted access. These security measures have significantly reduced the amount of trafficking. Still, transportation professionals must consider how physical and policy structures empower traffickers to peddle Native women and girls as victims.

Despite increased security at the Port of Duluth and other entry and exit points, human trafficking continues. Tribal communities near the borders with Mexico and Canada are especially vulnerable to international trafficking. A 2016 article in the *Canadian Journal of Sociology* characterizes the most dangerous highways as remote, underdeveloped wilderness or sparsely populated communities (9). Traffickers need transportation to cross borders through points of entry and exit without being detected.

A report on human trafficking of Native Americans in Oregon described commercial sex establishments that line

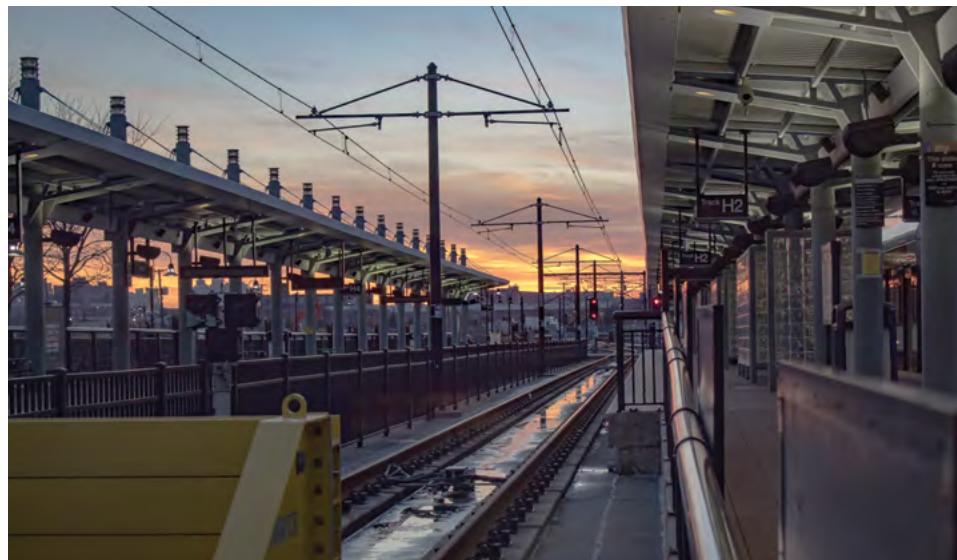


Photo: Shane Lynes, Unsplash

Empty and dark, this train platform is a study in changes needed to provide a safe environment in which women and girls travel—especially if they must be out to work late at night or early in the morning when transit is not well protected by the watchful eyes of other passengers.



Photo: Scott Horn, Unsplash

Moving missing people is not unlike moving goods—it takes transportation. Truck stops, bus stations, train platforms, and other places where people and goods are transported can serve as conduits for moving missing women and girls. When these locations are near—but not on—Indian land, they can be vectors for prostitution and trafficking.

the Interstate-5 corridor, including truck stops that facilitate transfers of sex trafficking victims between Mexican and Canadian borders (10). Federal prosecutors who were interviewed reported a surge in sex trafficking in areas such as southern Oregon, where adults travel to have sex with children they meet online. The same report confirms that rural children are those most often lured into prostitution through sex trafficking.

Interviewees working on or in close proximity to reservations reported instances of prostitution and human trafficking occurring most often at locations near—but not on—the reservation, such as highway truck stops. For example, some interviewees in the Oregon study mentioned prostitution and potential trafficking occurring in a tent erected near a highway truck stop just north of Klamath Falls—before the stop burned down. A significant amount of trafficking and prostitution of Native, Hispanic, and white women also reportedly occurs just outside of Warm Springs Indian Reservation, where pimps pick up young women that they take back

to Portland. One interviewee also reported knowledge of a young woman who had been recruited into trafficking through her attendance at an area community college. The report found that state officials are not meeting their legal obligations to the Native community with regard to the prevention of trafficking, prosecution of offenders, and protection of victims.

Now, to the Statistics

Each year in the United States, thousands of Native women and girls disappear or die. They vanish from tribal lands, rural communities, and cities—with no official accounting. According to an April 2021 U.S. Department of the Interior news release, approximately 1,500 American Indian and Alaska Native missing persons throughout the United States have been entered into the FBI National Crime Information Center (NCIC). And approximately 2,700 cases of murder and nonnegligent homicide of American Indians and Alaska Natives have been reported to the bureau's Uniform Crime Reporting Program (11). However, deep disparities exist between reporting databases that reflect inconsistencies in data collection for missing and murdered Indigenous women. Challenges in accessing

reliable data continue today, impeding policy makers' ability to make informed decisions to address the violence against these victims.

The Urban Indian Health Institute sheds light on the lack of accurate data, citing difficulty in obtaining data on violence committed against Indigenous women, difficulty in law enforcement's ability to track data, and challenges in identifying Native women (5). Tribal people can seem almost invisible to the rest of society and are often thought of in an idealized historical context, such as living in teepees. Until recently, many mainstream Americans have paid little attention to the issues Native Americans encounter as citizens of the United States. The Centers for Disease Control and Prevention cites murder as the sixth-leading cause of death among American Indian and Alaska Native women and girls up to age 44, many of whom are victims of human trafficking (12). With that in mind, transportation agencies and professionals can take multiple actions to reduce occurrences of human trafficking. But the first step is to better understand how social structures and policies have worked to devalue the lives of Indigenous women and girls and how perceptions influence travel behaviors.



Photo: Jeff Ferguson

Crying out for social justice, activist Shelly Boyd—a member of Washington State's Sinixt–Arrow Lake Band of the Confederated Tribes of the Colville Reservation—leads an awareness rally at a traditional intertribal Salmon Ceremony. The red handprint over her mouth symbolizes the silenced voices of missing and murdered Indigenous women and girls.

Complex Relationship with the Federal Government

Federal Indian law is complex. A unique legal and political relationship between American Indians and the U.S. government has reinforced social injustices and inequities. There are 574 federally recognized tribes in the United States (13). According to the U.S. Bureau of Indian Affairs (BIA), approximately 56.2 million acres are held in trust by the United States for various Indian tribes and individuals. Approximately 326 Indian land areas in the United States are administered as federal Indian reservations and also include pueblos, rancherías, missions, villages, and communities. About 55 percent of tribal people live in small rural towns, with the remainder residing in urban areas. For federal criminal jurisdiction purposes, Title 18 U.S. Code Section 1151 defines Indian Country as all land within the limits of any Indian reservation (including fee and trust land within reservation boundaries) and trust lands outside the reservation boundaries, including rights-of-way. BIA maintains the official title record for Indian Country lands. Based on BIA information, state departments of transportation (DOTs) typically maintain and update a map of Indian



Photo: Sailik Sengupta, Pixabay

There's a vast beauty to the desolate land in some parts of Indian Country, but the solitude shrouds a different type of silence. Every year, a large number of Indigenous women and girls are murdered or simply vanish to join the missing. Perhaps more alarming is that this is nothing new.

Country within their databases (14). These boundaries shape legal relationships.

The boundaries of Indian Country lands have many of the same law enforcement and jurisdictional limitations as the borders between the states. Unlike states, each tribe has its own unique history and relationship with the federal government.

Over generations, court decisions have changed the legal relationships between tribes and the federal government. In 1974, the U.S. Supreme Court decided in *Morton v. Mancari* that America Indians were not recognized as a racial group;

instead, as a people, they should be identified as a quasi-sovereign entity that is governed by the BIA in a unique fashion. The legal relationship between tribes and the federal government also is a political relationship that is augmented by treaties, executive orders, federal statutes, and further U.S. Supreme Court case law. These policies and laws define this relationship and the status of land tenure. This relationship is further complicated by the political nature of the government-to-government relationship, transportation services, and criminal jurisdiction by different authorities.

This relationship leaves tribes without legal provisions to protect their women and girls. The prosecution of crimes in Indian Country is constrained due to the complex nature of federal Indian law. In Indian Country, there are layers of federal laws, tribal laws, and even state laws. Prosecution of sexual assaults and rape depends on the type of crime, the location of the act, and the race of the perpetrator. The race issue resulted from a 1978 U.S. Supreme Court decision in *Oliphant v. Suquamish* that ruled that the tribe lacked criminal jurisdiction over non-Indians when the tribal nation became a domestic dependent nation within the United States. These federal laws create a jurisdictional void and lead criminals to believe they can commit crimes in Indian Country and get away with them.

However, in the 2021 case of the *United States v. Cooley*, the U.S. Supreme Court ruled unanimously that a tribal police officer may detain a non-Indian on

Three Types of Land

The three types of land on Indian reservations have different rules and jurisdictional challenges.

Tribal Trust: Land that is held in trust by the U.S. government for the use of the tribe as a whole or by allotments to individuals.

Tribal Fee: Fee Simple Absolute lands owned by the tribe from acquisition or gifting are the typical land tenure with which all Americans are familiar. Most of these will be converted to trusts but may not yet be because of mortgages or other debts associated with the properties.

Non-Indian Fee: Land owned by non-Indians within the reservation boundary. There are jurisdictional challenges on these lands because of *Brendale v. Confederated Tribes of Yakama*, which ruled that non-Indian owners within reservation boundaries are not necessarily under the jurisdiction of the tribe but rather the county or state.

a public highway crossing a reservation for suspected violation of federal or state law and may perform a search related to that detention while the suspect is held for transport to state or federal authorities for prosecution.

In arriving at this decision, the U.S. Supreme Court also was concerned that failure to recognize authority to detain suspected non-Indian offenders could pose serious threats to public safety in Indian Country. The Court noted that several state and lower federal courts had recognized this authority, but several Supreme Court opinions assumed that such authority already existed. By extension, such rulings are a move toward improving the safety of Indigenous women.

Legal Solutions

Despite the 2021 *United States v. Cooley* decision previously mentioned, tribes continue to need enhanced jurisdiction over non-Indian perpetrators living in Indian Country, the ability to protect women from violent crimes, and the capability to promote a coherent framework of laws to maximize enforcement effectiveness.

The Major Crimes Act, which federal prosecutors use to prosecute Indians for major crimes committed against Indian and non-Indian victims, could be simplified to cover all felony assaults under Section 113 of the federal Criminal Code.

The Violence Against Women Act expired in December 2018, and a temporary reauthorization expired on February 15, 2019. Signed into law on March 16, 2022, the act includes jurisdictional enhancement for tribal courts dealing with non-Native men.

During the August 12, 2020, webinar, Walking Toward Justice in Indian Country, moderated by the author and including a national panel, New Mexico's then-U.S. Representative Deb Haaland noted that, "among the most crucial pieces of legislation is the Not Invisible Act of 2019." Passed into law in 2020, the act established an advisory committee comprised of law enforcement, tribal leaders, survivors of trafficking, and family members to address the epidemic of missing and murdered Indigenous people and to



Photo: U.S. Department of the Interior

The red shawl that U.S. Secretary of the Interior Deb Haaland drapes over a chair in her office is a vivid—and poignant—symbol of the alarming number of Indigenous women and girls who have gone missing or been slain, a "crisis that Native communities have faced since the dawn of colonization," she laments.

find jurisdictional solutions to the complex criminal law framework on tribal lands.

Now U.S. Secretary of the Interior, Haaland—a member of the Pueblo of Laguna tribe and the first Native American to serve as a Cabinet secretary—has worked to develop protocols for new and unsolved cases of missing and murdered Native women and girls. These efforts include increasing coordination and communication between state, federal, tribal, and local law enforcement to improve collection of data and statistics related to tracking missing Indigenous people.

Tribal governments, such as the Navajo and Choctaw nations, also have passed legislation to protect women and children from trafficking. The Choctaw Nation provides guidelines for treatment of human trafficking victims, which state that they shall be housed in a shelter; not be detained in jail; not be fined or penalized; receive prompt medical care, food, and other assistance, as needed; be offered legal assistance; and be provided protection if safety is at risk (Choctaw Nation Criminal Code).

Transportation Agencies Can Help

Transportation agencies can improve travel and transportation safety for Native women and girls by continuing to share information with community members, as well as criminal justice, social service, and medical personnel, all of whom can help save victims and get pimps and traffickers off the street.

The U.S. Department of Transportation (U.S. DOT) initiative, Transportation Leaders Against Human Trafficking, was formed in 2012 for transportation and travel industry stakeholders to maximize the transportation industry's collective impact in combating human trafficking.¹ The initiative provides transportation agencies with resources for training, public awareness, and agency coordination.

State DOTs also can harness their employees and technology to fight trafficking, aid victims, and support critical decision making. The Transportation Research Board's (TRB's) National Cooperative Highway Research Program Project 20-121, "State DOT Contributions to the Study, Investigation, and Interdiction of Human Trafficking" is developing a guide accompanied by tools to support effective training, policy, and collaborations for mitigating human trafficking.² The project addresses leadership, field staff, contractors, industry stakeholders, and collaborative partners.

By improving awareness of human trafficking, transit agencies are working to make their systems and passengers safer. As detailed in TRB's *Transit Cooperative Research Program Synthesis 146: Transit Security Preparedness*, 15 percent of the respondents surveyed by transit agencies said that they have experienced at least one human trafficking incident (15). Agencies are collaborating with law enforcement, special task forces, or both to counter the problem and offer training specifically focused on combating human trafficking, as

¹ See Transportation Leaders Against Human Trafficking at <https://www.transportation.gov/TLAHT>.

² See project details at <https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=4378>.

well as taking action to better inform their transit customers. An upcoming primer, guide, and toolkit from TRB's Airport Cooperative Research Program will help airport operators create and implement a comprehensive anti-human trafficking action plan.³ These resources will address all forms of human trafficking and allow airport operators to tailor approaches to their unique situations.

In December 2021, U.S. Secretary of Transportation Pete Buttigieg called upon transportation stakeholders to join U.S. DOT to fight the trafficking problem. "Human trafficking takes place on every mode of transportation in America, and we must change that," he stated. "I ask all transportation professionals to join this effort. And it's equally important for commuters and travelers to be empowered to recognize and report signs of human trafficking anywhere it happens in our transportation systems" (16).

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About the Author

Margo Hill is a Spokane tribal member who grew up on the Spokane Indian Reservation. She served as the Spokane tribal attorney for more than 10 years and as a Coeur d'Alene Tribal Court judge. As such, she received letters from the U.S. Attorney's Office in Washington State in which it declined to prosecute cases of major violent crimes as she worked to bring perpetrators to justice in the complex criminal law scheme of Indian Country. Her fight for justice continues.



Further Reading

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³ See project details at <https://apps.trb.org/cmsfeed/TRBNetProjectDisplay.aspx?ProjectID=4378>.

Not on My Bus! Not on My Train! Not in My Community!

Tips for Spotting and Reporting Suspected Trafficking

KRISTEN JOYNER

The author is president of KJ Backpack, which connects workforce development, leadership, and communication trainers with transportation professionals. She also is executive consultant and trainer for South West Transit Association in Fort Worth, Texas.

The transportation industry is tasked with providing safe passage of people and goods across the United States. This is part of its core mission statement. With that in mind, the industry wants to put traffickers on notice.

What is human trafficking?

U.S. law defines human trafficking as the use of force, fraud, or coercion to compel a person into commercial sex acts or labor against that individual's will. However, there is one exception: Inducing a minor into commercial sex is considered human trafficking, regardless of the presence of force, fraud, or coercion.

How does human trafficking happen?

The Action–Means–Purpose Model can help clarify the federal law. Human trafficking occurs when a perpetrator—often referred to as a trafficker—takes an **Action**, and then employs the **Means** of force, fraud, or coercion for the **Purpose** of compelling the victim to provide commercial sex acts, labor, or services.

How is transportation used to support human trafficking?

In a 2018 Polaris study, 127 survivors of sex and labor trafficking were interviewed about their experience with the transportation sector [1]. These survivors—men and women—reported that buses, trains, airlines, over-the-road coaches, trucks,

rented vans, boats, shipping containers, ride-shares, taxis, and more were used to facilitate their movement, as well as the movements of others.

This means transportation is part of the problem.

In the same 2018 project, researchers discovered that many of the same forms of transportation were used to help survivors escape their traffickers, sometimes successfully and sometimes not. Among survivors surveyed, 42 percent stated that buses were used to facilitate their exploitation, and 26 percent reported that public transit played a role in at least one exit attempt [1].

Survivors provide excellent information on what can work to help them. The transportation industry must be ready to watch and report when—and if—potentially dangerous situations are observed.

How can transportation be part of the solution?

Train staff to look and listen for signs of trafficking.

Traffickers recognize and take advantage of people who are vulnerable, but there is no "one way." Look and listen for the following from potential victims or traffickers:

- Adults who are not in possession of their own passport and travel documents;

- People who are not allowed to speak for themselves (e.g., potential traffickers answer questions and make decisions for victim);
- People with little to no knowledge of their destination or who is meeting them;
- Scripted or inconsistent stories;
- Traveling with few personal items;
- Clothing inappropriate for climate or used to conceal signs of abuse;
- Overly fearful or anxious behavior;
- Verbal abuse from the potential trafficker;
- Controlling behavior (e.g., potential victim is unable to move freely or interact with other passengers);
- Physically aggressive behavior (e.g., potential trafficker shoves a victim or violently grabs an arm);
- Signs of malnourishment, physical abuse, or exhaustion;
- Little to no eye contact; and
- Individuals in possession of multiple cell phones.

Provide a clear way to report.

The National Human Trafficking Hotline is answered 24 hours a day, seven days a week. Call or text **888-3737-888**—it is easier to remember if written this way.



Photo: RISE

The haunting beauty of hope shines through in art born from the pain and loss of young human trafficking survivors. Created by 12- to 18-year-old girls at Restoring Identities After Sexual Exploitation (RISE), an Oklahoma shelter and nonprofit advocacy group, the artwork is used in a converted Tulsa Transit bus—a rolling classroom where frontline employees and the public learn to identify and help victims.

Save the number in your cell phone! Or text “**BeFree**” to **233733** (this number spells BeFree on the keypad) to discreetly and confidentially communicate with a trained professional.

Give frontline staff clear instructions for contacting dispatch or law enforcement.

- If employees witness a crime in progress, they should call 911;
- If employees observe suspicious behavior while transporting, they should contact dispatch for direction; and
- Ensure that all dispatchers and communications teams know what to ask and how to respond.

Provide survivor-informed messaging and materials.

Busing on the Lookout, Truckers Against Trafficking, and A-21 offer free materials that can be obtained or printed directly from their websites and displayed inside vehicles and in bus stations, transit centers, airports, rest areas, truck stops, and ports.

Close the reporting loop.

Make identification of potential human trafficking situations a part of incident reporting. This allows supervisors and law enforcement to track hotspots and plan accordingly.

Provide a permanent way out.

- Distribute free bus passes, tickets, and other means of transportation to organizations that help victims; and
- Hire survivors of human trafficking.

Never approach!

Do not approach or quiz a potential trafficking victim. Instead, note the 5Ws and H: who, what, when, where, why, and how. Then report!

Care and act!

Care enough to be aware and do something. If transportation agencies, their employees, and transit customers work together, the industry can do its part to stop human trafficking—modern-day slavery—in its tracks.

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Learn More

1. Read about recognizing labor trafficking at <https://polaris-project.org/labor-trafficking/>.
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5. A-21 provides messaging and training for a broader audience to understand what human trafficking looks like in the United States and abroad. The organization provides a message of Reach, Rescue, and Restore for victims and survivors of sex and labor trafficking. See the video, *Can You See Me*, at <https://www.a21.org/content/can-you-see-me/grbis0>.
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Innovating an Equitable, Resilient, Sustainable, and Safe Transportation System

After an all-virtual conference in 2021, the Transportation Research Board's (TRB's) 101st Annual Meeting welcomed transportation professionals in person to the Walter E. Washington Convention Center in Washington, D.C., January 9–13, 2022. A smaller but motivated—and masked and vaccinated—crowd convened for committee meetings, poster and lectern sessions, and a keynote address from U.S. Department of Transportation (U.S. DOT) Secretary Pete Buttigieg.

Speaking via video teleconference in a "fireside chat" with TRB Executive Committee chair Susan Shaheen and vice chair Nathaniel Ford, Buttigieg discussed the role of research in fulfilling the promise of the recently passed Infrastructure Investment and Jobs Act of 2021 and the crucial need for equity, safety, and innovation in transportation now and in the future.

Sessions and workshops addressed topics of interest to policy makers, administrators, practitioners, researchers, and students—many focused on the meeting's theme: "Innovating an Equitable, Resilient, Sustainable, and Safe Transportation System." Freight and logistics expert Anne Strauss-Wieder delivered the 2022 Thomas B. Deen Distinguished Lecture, "Evolving with Rapidly Shifting Supply Chains and Freight Systems: The Past, the Present, and the Emerging Future."

Details and highlights appear on the following pages.

■ Swiss Federal Institute of Technology Lausanne students (*left to right*) **Georg Anagnostopoulos, Pengbo Zhu, Sohyeong Kim, and Jasso Espadaler Clapés** grab a selfie at the kickoff of the 101st TRB Annual Meeting.

■ A take on an old-fashioned crossroads sign helps attendees navigate the Walter E. Washington Convention Center.

■ Chair's Plenary keynote speaker **U.S. Department of Transportation Secretary Pete Buttigieg** addressed transportation equity, inclusion, and innovation in a virtual setting, giving all attendees the opportunity to listen from other rooms in a follow-up Q&A session.



1



2

Annual Meeting photographs by Risdon Photography.



3

Intersections

1 Crowds flock to the Exhibit Hall to network and see the latest innovations in transportation technology and materials.



2 **Rebekah Straub-Anderson** and **Noel Comeaux** exchange insights during the All-Chairs Meeting.

3 Twenty-four students from 13 schools participated in the 2022 TRB Minority Student Fellows Program, with research backgrounds ranging from civil engineering to sustainable build environments to urban and regional planning. Pictured are (left to right) **José Portillo**, **Ash Avila**, **Christopher Rocha**, **Valencia Stewart**, **Isaac Zuniga**, **Kamalen Santos-Diaz**, **Esther Bia**, **Jervani Thompson**, **Jennifer Restrepo**, **Dunsin Fadojutimi**, **Daniel Romero**, **Isabel Gutierrez**, **Jesús Molina**, **Jayson Francois**, **Sarah De La O**, **Benson Long** and **Laura Camarena** (2021 Alumni Scholarship Awardees), **Omar Galicia**, and **Jeannine Mbabazi**.



2

3

4 **Valencia Stewart**, Texas Southern University, participates in the Minority Student Fellows Orientation.



4

5

5 **Walter (Jeff) Moore** (left), chair of the Public Engagement and Communications Committee, and committee members **Terri Parker** and **Pamela Lebeaux** (second from right and far right, respectively) join the winners of the 15th Annual Competition for Communicating Transportation Concepts with John and Jane Q. Public. They are (left to right) **Tim Haile**, **Rebecca Krawiec**, **Ryan Brown**, **Tara Andringa**, **Samantha Dubay**, and **Katie Caskey**. The committee sponsors the competition.



6

7

6 At the TRB booth, participants browse through issues of the *Transportation Research Record*, in which their research papers may be published.

7 Overseeing the organization and activities of TRB's standing committees, the 2022 Technical Activities Council (TAC) are (front row, left to right) **Bob Hazlett**, **Pamela Keidel-Adams**, **Ann Brach**, TAC Chair, **Avery Grimes**, **Libby Rushley**, **Michael Griffith**, (back row, left to right) **Stephen Maher**, **Kathryn Zimmerman**, **Mark Reno**, **Allison Yoh**, **Richard Bornhorst**, **Tara Cavalline**, and **Pasi Lautala**.

2022 TRB Annual Meeting Highlights

Sessions and Workshops

1 TRB Executive Committee Chair **Susan Shaheen** (left) discusses a Tennessee case of alternative truck routing in freight intermodal connectors with student researchers **Grace Mbaiji** (center) and **Jeannine Mbabazi**, both of Tennessee State University.



1



2

2 **Chaitanyaganesh Bhat** (left), Asphalt Institute, and **Milena Rangelov**, FHWA, lead workshop attendees in a participation activity about the information needed to determine the potential environmental impact of pavement materials.



3



4

3 **John Hildreth**, Western Carolina University, comments on advancing low- and zero-emission marine vessel technology options.



5



6

4 **Adam Schmidt**, North Carolina State Transit, presents his research during the 3-Minute Thesis competition.



5

5 **Esther Bia**, University of New Mexico, shares details of the impact of bus rapid transit on traffic safety.



7

6 **Lynn Scholl**, Inter-American Development Bank, presents a workshop on socially inclusive transportation development in Latin America and the Caribbean.



8

7 **Theresa Dao-Ngo**, Port of Long Beach, participates in a panel discussion about public agency perspectives on supply chain disruptions.

8 **John Myers**, Missouri University of Science and Technology, presents one of several talks on innovative materials that extend the life of bridges.



Committees

1 Laurel Radow, member of the Transportation Systems Resilience Section, discusses the September–October 2021 issue of *TR News*, which focused on lessons the transportation industry learned during the 20 years since the 9/11 terrorist attacks.

2 Diversity, Equity, and Inclusion Committee Chair **Carol Abel Lewis** leads a discussion about equity in transportation.

Blue Ribbon for Best Practices

TAC Chair Avery Grimes presented Blue Ribbon Awards for best practices of outstanding technical activities committees in the following areas:

- 1** Identifying and Advancing Ideas for Research: Quality Assurance Management Committee, chaired by **Tim Aschenbrener**;
- 2** Attracting and Preparing the Next Generation of Professionals and Scholars in TRB: Urban Freight Transportation Committee, chaired by **William (Bill) Eisele**;
- 3** Moving Research Ideas into Transportation Practice: Transportation Needs of National Parks and Public Lands Committee, chaired by **Natalie Villwock-Witte**;
- 4** Moving Research Ideas into Transportation Practice: Low-Volume Roads Committee, chaired by **Laura Fay** (accepted by **David Jones**);
- 5** Contributing to Improving the Management and Operations of TRB Committees: Equity in Transportation Committee, chaired by **Tracee Strum-Gilliam** (left) and **Gloria Jeff**; and
- 6** Increasing the Committee Membership and Friends, Especially from Groups That Are Historically Underrepresented in Transportation: International Trade and Transportation Committee, chaired by **Juan Carlos Villa** (see Page 47).



2022 TRB Annual Meeting Highlights

Committees

(continued)

3 Irene Marion, U.S. DOT, addresses the Equity in Transportation Committee via Zoom during its standing-room-only business meeting.



4 Tracy Duval, FHWA, shares what it means to be successful in a transportation agency during the Minority Student Fellows Career Panel. Other panelists included (*left to right*) **Karl Simon**, U.S. Environmental Protection Agency; **Ian Rowe**, U.S. Department of Energy; and **Latoya Jones** (*far right*), FHWA.

5 Young Members Council on Aviation Vice Chair Ryan Dittoe gives a leadership update.

6 Engineering Geology Committee Chair Vanessa Bateman presides over a lectern session on stability problems.



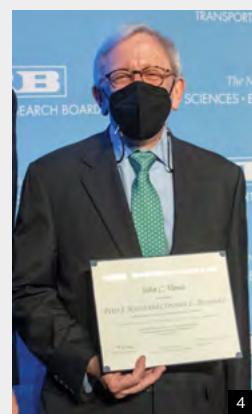
Paper Awards

The Fred Burggraf Award is presented to researchers age 35 and younger. Recipients are shown from left to right.

1 Susan Hotle and Osama Alsalous, Virginia Polytechnic Institute and State University, received the Burggraf Award for best aviation paper.



2 Amir Golalipour, FHWA, and **Varun Veginati**, Engineering and Software Consultants, Inc., received the Burggraf Award for best transportation infrastructure design and construction paper. Not pictured: **David J. Mensching**.



3 Wesley Darling, University of California, Berkeley, received the William W. Millar Award for best paper in the field of public transportation. Not pictured: **Candace Brakewood**, **Emily Carpenter**, **Tami Johnson-Praino**, and **Carole Turley Voulgaris**.

4 Peter J. Kirsch of Kaplan, Kirsch, and Rockwell, received the John C. Vance Award for best paper on legal resources. Not pictured: **Christian L. Alexander**.

5 Edith Arámbula Mercado and **Amy Epps Martin**, Texas A&M Transportation Institute, shared the K.B. Woods Award for best design and construction paper with **Fawaz M. Kaseer**, Michigan Department of Transportation.

Major Awards

1 Director of Freight Planning for the New Jersey Transportation Planning Authority, **Anne Strauss-Wieder** is the recipient of the 2022 Thomas B. Deen Distinguished Lectureship. Her public- and private-sector experience over more than 40 years has involved supply chains, industrial and economic development, resilience, and multimodal freight movement. She has authored numerous assessments of emerging trends and issues and works proactively on addressing key regional freight issues and trends. Strauss-Wieder is recognized for her contributions to the transportation community in freight mobility, resilience, business continuity, and “freight as a good neighbor” effective practices.



2 **Hani S. Mahmassani**, the William A. Patterson Distinguished Chair at Northwestern University in Evanston, Illinois; director of the Northwestern University Transportation Center; and director of U.S. DOT's Center of Excellence on Telemobility, is the 2021 recipient of the Roy W. Crum Distinguished Service Award. Named for TRB's former director, who served from 1928 until his death in 1951, the award recognizes outstanding leadership in transportation research or research administration. Mahmassani is recognized for his distinguished achievements in modeling and understanding individual behavior in complex networks in order to plan, design, and operate these systems to achieve societal and sustainability objectives.



3 Recognized for his outstanding service to TRB and advancement of innovations in public transportation partnerships, **Vincent Valdes** is the 2021

recipient of the W.N. Carey, Jr. Distinguished Service Award. He is executive director of the Southwestern Pennsylvania Commission, the designated metropolitan planning organization for a 10-county region, including the city of Pittsburgh. He leads a team of planners, program managers, transportation specialists, and engineers who work to create a common regional vision and transportation implementation program for southwestern Pennsylvania communities. The award is named for TRB's executive director from 1967 to 1980.

4 **Jacquelyne D. Grimshaw**, vice president for Government Affairs at the Center for Neighborhood Technology in Chicago, Illinois, is the 2022 recipient of the Sharon D. Banks Award for Humanitarian Leadership in Transportation. She is recognized for championing the interests and

concerns of—and the impacts felt by—those who are not usually at the decision table. She is honored for her thoughtful, effective, and people-oriented leadership style, her groundbreaking implementation of practical environmental justice initiatives, and the hundreds of colleagues she has mentored to become more effective professionals and better people. The biennial award was established in memory of Sharon D. Banks, former general manager of AC Transit in Oakland, California, and past TRB Executive Committee chair.

5 TRB's Executive Committee established the Robert E. Skinner, Jr. Distinguished Transportation Research Management Award to recognize outstanding achievement in the management, administration, promotion, fostering, and implementation of transportation research. In

addition to establishing the new award, the Executive Committee selected **Robert E. Skinner, Jr.**, TRB executive director from 1994 to 2015, as its inaugural recipient. Under Skinner's oversight, TRB significantly strengthened the multimodal and multidisciplinary range of its programs, inaugurated major communications initiatives, fostered international research partnerships and coordination, and worked proactively to enhance the diversity of TRB's committees, programs, and staff.

6 **Thomas B. Deen**, who served from 1980 to 1994 as TRB's eighth executive director, stands with **Anne Strauss-Wieder**, recipient of the award named for him. The lectureship recognizes the career contributions and achievements of an individual in one of the areas covered by TRB's Technical Activities Division.

Executive Committee

Each year, the TRB Executive Committee selects a topic worthy of deeper analysis to address in a policy session. The 2022 policy session topic was decarbonization in the transportation sector, with the following panel of experts (*left to right*):

- 1 Chris T. Hendrickson**, Carnegie Mellon University;
- 2 Young Tae Kim**, International Transport Forum; and
- 3 Rachel Muncrief**, International Council on Clean Transportation.

New Leaders Steer the Executive Committee

Nathaniel P. Ford, Sr., (right) is the 2022 chair of TRB's Executive Committee. He is chief executive officer of the Jacksonville Transportation Authority (JTA) in Florida, a state agency responsible for multimodal public transportation and infrastructure programs. Under his guidance, JTA is developing the Ultimate Urban Circulator, a 10-mile autonomous vehicle network in downtown Jacksonville that will modernize and expand its Skyway automated people mover system.

Ford is an advocate of innovative multimodal transportation solutions, complete streets, walkable neighborhoods, public-private partnerships, and transit-oriented development. During his nine years at JTA, he has received numerous awards for his transformational and community-focused initiatives in the Northeast Florida community. In 2020, he was named the American Public Transportation Association (APTA) Outstanding Public Transportation Manager. That same year, JTA won the APTA Innovation Award for its response to the COVID-19 pandemic.

Ford holds an Executive MBA from the Davis School of Business at Jacksonville University and a Bachelor of Applied Sciences in organizational



leadership from Mercer University in Macon, Georgia.

He served as the Executive Committee's 2021 vice chair and also has served as chair of the committee's International Activities Subcommittee, chair of its Task Force on Diversity and Inclusion, and chair of the American Public Transportation Association. Ford's distinguished career includes tenures as chief executive officer of the San Francisco Municipal Transportation Authority and the Metropolitan Atlanta Rapid Transit Authority.

The 2022 TRB Executive Committee vice chair is **Shawn Wilson**, (left) Secretary of the Louisiana Department of Transportation and Development. He serves as chair of the National Cooperative Highway Research Program research panel on the Administration of Highway and Transportation Agencies. He also is president of the AASHTO Executive Committee.

James F. Albaugh, Joel Jundt, Drew K. Kodjak, Carol Abel Lewis, and Steward T.A. Pickett are new members of the Executive Committee. Reappointed members are **Michael F. Ableson, Diane Gutierrez-Scacitti, Stephen W. Hargarten, Chris T. Hendrickson, Ashby Johnson, Julie Lorenz, and Michael R. McClellan**.



Executive Committee

(continued)

1 2021 TRB Executive Committee Chair Susan Shaheen hosts the Chair's Plenary Session.

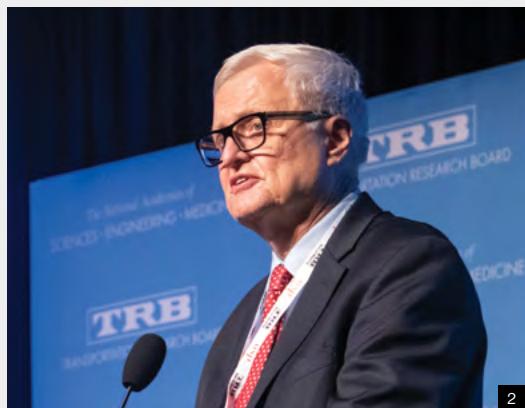
2 TRB Executive Director Neil Pedersen delivers a progress report on TRB's initiatives.

Also participating in the Executive Committee's agenda and deliberations are

3 Julie Lorenz, Kansas Department of Transportation;

4 Michael Berube, U.S. Department of Energy;

5 Carol Abel Lewis, Texas Southern University, and **Hani Mahmassani**, Northwestern University;



6 Paul Skoutelas (left), American Public Transportation Association, and **Randell Iwasaki**, Amazon Web Services; and

7 Marie Therese Dominguez, New York State Department of Transportation.



Photo: Jan Vašek, Pixabay

Evaluating the Airport Traveler's Perspective

PATRICIA RYAN AND
KOMAL SOOD

Ryan is the director of aviation and Sood is a senior project manager at IOS Partners in Miami, Florida.

Above: From seniors to children, vacationers to business execs, and all travelers in between, how do airports gauge the satisfaction of their many types of customers? What leaves travelers with a good impression is good for everyone and can translate into revenue.

Airports are dynamic communities that increasingly have become places where people dine, shop, relax, work, and interact. In many ways, airports are evolving into bustling mini-cities that are no longer simply meeting the basic needs of their customers, but creating unique customer experiences. This expanded role creates challenges as airport operators continue to try to understand and address the needs of their diverse customer base.

This article is based on the information and research documented in *Airport Cooperative Research Program (ACRP) Research Report 231: Evaluating the Traveler's Perspective to Improve the Airport Customer Experience* (1). Methodologies and practices have been outlined to assist airports and other transportation organizations in employing a more customer-centered approach and rethinking the airport experience through the customer's perspective.

Evaluating Customer Needs and Wants

Customer experience is influenced by the people customers interact with during their experience and during their interactions with the environment itself. In an airport, travel tends to be stressful for many passengers, and they are often more sensitive to how they are treated at the airport. Therefore, a positive interactive experience is crucial in gaining customer satisfaction and loyalty, which ultimately translates to increased revenue. According to Airports Council International, an airport membership representative organization, an improvement of 1 percent in passenger experience translates into an increase of 1.5 percent in nonaeronautical revenues, such as purchases in airport shops (2).

Elements critical to the customer experience were identified during ACRP Research Report 231 research. A select group that may apply across the transportation industry are outlined in the following sections.

MEET BASIC NEEDS FIRST

Being able to recognize customer requirements, expectations, and values is considered vital for enhancing the customer experience because the minimum acceptable services or products provided may not be sufficient to create a positively differentiated experience (3). However, in order for customers to recognize and enjoy a positive experience, research stresses that basic needs have to be met first. When they are not met, the added value of any “wow factors” is greatly diminished. Figure 1 incorporates Maslow’s Hierarchy of Needs at an airport indicating the need to satisfy basic needs at the required level before progressing to the next level. The required level that is considered “basic” depends on the character, culture, and present needs of the customer. This varies within and between organizations.

PROVIDE TRANSPARENT AND EASY ACCESS TO INFORMATION

Organizations need to keep customers informed throughout their experience. The Official Aviation Guide (OAG) conducted a survey of more than 2,000 travelers and found that travelers value accessible and trustworthy information substantially more than emerging technologies such as robotics and biometrics (4). Customers feel in greater control of their journey when they have easy and transparent access to information on the key elements that impact their experience. This includes information on wait times, transportation status, traffic information, baggage tracking, and other factors that may disrupt the journey.

ENHANCE COLLABORATION WITH STAKEHOLDERS

Research on airports suggests that most travelers do not distinguish between responsible parties for the quality of services—whether that party is an airline, the Transportation Security Administration, Customs and Border Protection, concessionaires, or airport management. Creating a seamless experience, therefore, requires the airport to collaborate more closely with its business partners. This may include improving communication between parties,

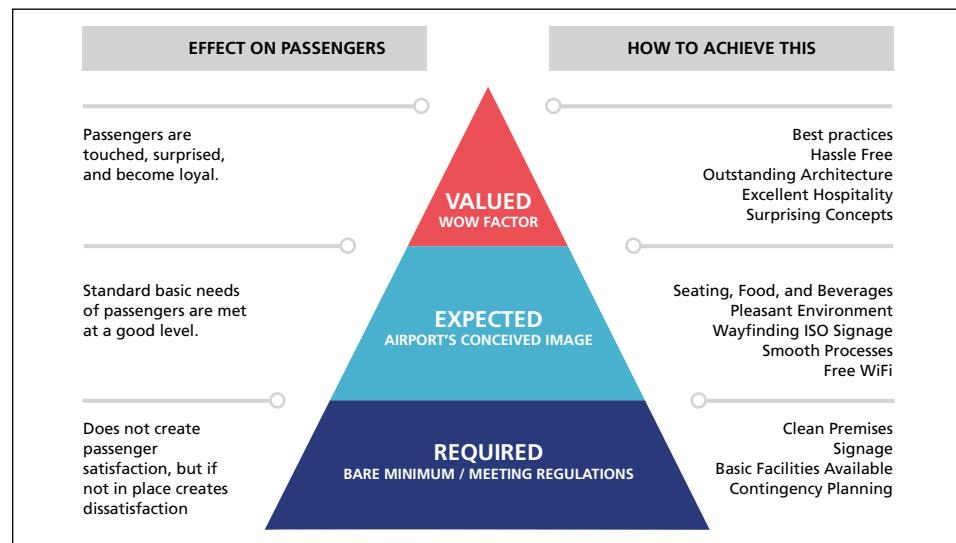


FIGURE 1 Hierarchy of needs for an airport illustrating that passengers’ basic needs must be met first for passengers to appreciate the “wow factor.” [ISO = International Organization for Standardization. (Source: ACI Europe, 2014.)]

scheduling regular meetings with all stakeholders, offering incentives to improve performance (such as inclusion of business partner staff in reward and recognition programs), organizing joint data collection initiatives, collaborating on customer experience initiatives, and developing shared customer experience standards.

Customer Experience Plan

A customer experience approach requires an understanding of what matters most to customers. A customer experience plan is a beneficial tool that allows an organization to define its customer experience strategy, identify its specific customer needs, and develop targeted and measurable actions to address them.

GAP ANALYSIS

The first step is to conduct an evaluation of the different perspectives of the customer experience. It is important to consider several perspectives in the gap analysis to ensure that the actions an organization is taking meet the *actual* needs of its customers rather than the *perceived* needs (see Figure 2, Page 22).

A thorough evaluation of customer experience gaps involves the identification of differences between the following:

- The customer’s current versus ideal customer experience,
- The customer’s current experience versus the organization’s perspective of the customer’s current experience, and
- The customer’s perception of the ideal experience versus the organization’s perception of the ideal experience.

In conducting this type of analysis, organizations may find differences between these perspectives and can take necessary actions to align them.

ALIGN MISSION, VISION, GOALS, AND OBJECTIVES

Using the results of gap analysis and the organization’s customer experience strategy, specific customer experience goals and objectives should be developed at each departmental level within the organization. These should then be translated into a set of simple standards or principles to guide behavior throughout the organization, including the front line. It is important that all employees understand the purpose and intent of the organization’s customer experience strategy, goals, and objectives, and their application to each employee’s specific job responsibilities at the departmental and individual levels.

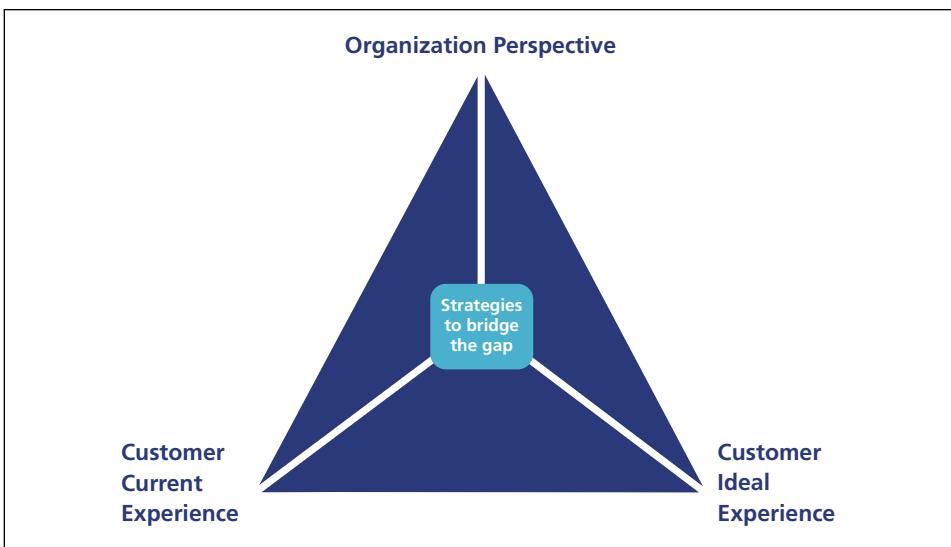


FIGURE 2 Assessment of customer experience gaps.

This is critical to ensure unified messaging and actions across the airport to create a better customer experience.

DEVELOP A CUSTOMER EXPERIENCE PLAN

The next step is to build a customer experience plan to develop and prioritize strategies/initiatives to bridge identified gaps. The plan should include benchmarks and key performance indicators (KPIs) to measure progress toward achieving established goals and objectives.

When developing benchmarks and KPIs, the organization should involve representatives from all departments and stakeholders in the customer experience to ensure a united message and accountability for meeting objectives. The benchmarks established should be realistic and achievable. Gradual improvements and higher standards can be set over time to ultimately achieve the desired outcome.

Impact of the Employee Experience

Research indicates that customer interface with staff is a critical element of the customer experience. An effective talent management system is crucial to ensure the right employees—with the right training and resources—have been selected.

In order to transform the customer experience, it is important to first examine what constitutes the employee experience and how this can be improved. Employee experiences are the sum of all of the interactions employees have with the organization, including relationships with managers, coworkers, and customers, as well as experiences with the physical work environment, technology, and work processes. Because these interactions shape how employees perceive the organization, they also have a direct effect on how employees perform their jobs, which then impacts the service that is delivered to customers.

Numerous surveys and studies have demonstrated a strong link between the employee experience and customer experience. Organizations that invest in employee experience not only outperform their competitors on customer metrics but, on average, are four times more profitable (5). Further empirical evidence supports that engaged employees and happy customers bring in more revenue to the organization. A study on international airport passengers showed that on average an unhappy passenger spends \$14 at the airport but a happy passenger spends \$21. With an estimate of 100,000 passengers per day, in a year, that's a difference of \$255 million (6).

Engaging in talent management practices that support the customer experience can enhance employee engagement. This often involves systematically designing and aligning organizational practices such as recruitment, selection, training, leadership development, employee recognition, performance management, and succession planning.

When an organization invests in its employees, employees are likely to become more engaged and motivated to improve job competency and perform well in their jobs. This engagement reflects positively in the customer experience through a more dedicated, patient, and empathetic workforce. Leaders and managers can greatly enable their employees when they are supportive and reinforce behaviors that contribute to customer experience.

Employee engagement is a complex and broad issue that involves how workers employ and express themselves physically, cognitively, and emotionally on the job. Assessing employee engagement requires effort from everyone in the organization. Combining different metrics, such as conducting employee stay interviews along with regular pulse surveys and a more comprehensive annual engagement assessment effort, can offer organizations a holistic and comprehensive understanding of the areas that employees are happy about, as well as areas where change is desired. This allows leadership to make informed decisions regarding employee experience and ultimately to enhance the overall customer experience. Figure 3 provides methods and metrics for assessing levels of employee engagement.

No matter which employee engagement metrics are utilized, it is important to thank the employees for their participation and communicate the high-level results. It also is important to identify a few key areas to improve and focus on, and communicate to employees what actions will be taken to address areas of concern. Communicating back to the employees ensures their voices have been heard and sends the message that the organization is committed to improving the work experience. This creates a positive loop by enhancing actual engagement and

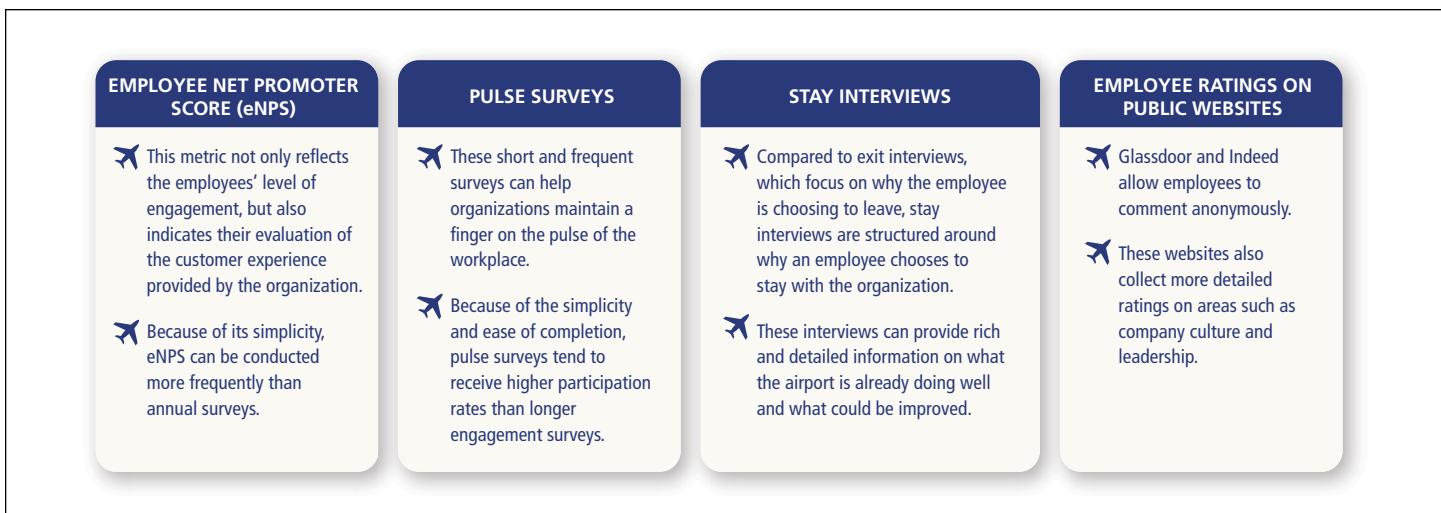


FIGURE 3 Methods and metrics for assessing levels of employee engagement.

encouraging more participation in future engagement efforts.

Tools and Methodologies

Numerous tools and methodologies can be utilized to evaluate the customer's perspective and a select few are presented in this section.

SEGMENTATION AND DEVELOPMENT OF PERSONAS

Segmenting customers allows an organization to obtain better insight and understanding of the perspectives of various customer groups. Research indicates there are notable differences among different segments of customers, particularly in the aviation industry. Organizations need to delve beyond general customer segments to obtain adequate insights into their customers' characteristics, core values, and drivers. Customer segmentation reveals who the customers are but does not provide an understanding of their needs and motivations. To accomplish this, the creation of customer personas is necessary. The development of a persona should be reflective of the organization's customer in regard to their personal characteristics and cultural, behavioral, and unique sensitivities.

For the airport industry specifically, a deep understanding of the behaviors

and needs of the passenger is vital to achieving high levels of customer service and developing new efficiencies in airport operations (7). The creation of personas provides the airport and its stakeholders with a better understanding of its travelers' needs, motivations, sentiments, and consumption habits. Personas allow the airport to focus on a manageable set of travelers sharing similar characteristics, rather than trying to individualize each traveler. Creating personas backed by data also allows the airport to better empathize with—and address—the needs of its traveler segments that have unique needs. Developing personas for airports involves the following:

- Collating and analyzing existing data to identify the nature of travelers at the airport;
- Establishing preliminary segments based on the existing data, such as grouping travelers generationally;
- Gathering additional data to better understand needs, motivations, state of mind, consumption habits, and so on, through stakeholder workshops, surveys, focus groups, social media analysis, and review of community data such as local economic data (e.g., employment, age, marital status, income, and family characteristics);

- Analyzing the data to identify patterns and commonalities to build specific personas unique to the airport—a key aim of creating personas is to empathize with and internalize the mindset of the airport passengers, and then to create a representation of the goals and behaviors of a hypothesized group of users; and
- Developing a journey map from the traveler's perspective to identify key pain points and solutions to alleviate these, thereby enhancing the customer experience.

JOURNEY MAPPING

Journey mapping can be a highly effective tool in understanding the customer's perspective. Basic journey mapping tools allow an organization to evaluate the customer's experience at specific touchpoints throughout the journey. By visually walking through these touchpoints from the customer's viewpoint, an organization can determine where it is succeeding or where customers may be experiencing challenges and encountering negative sentiments during their journey. Then, these data can be used to design interventions to alleviate pain points and improve customer experience.

While useful, basic journey maps often fall short of providing a complete picture



FIGURE 4 Template of a persona's journey map recording sentiment at each journey point.

of the customer experience. Sublayers of the journey can be created to gain greater insight into the customer experience. Successes, moments of truth, and traveler pain points can be identified by utilizing a combination of methodologies. One way to augment the journey map includes using persona-specific journeys to better understand the unique needs, sentiments, and pain points of each persona. Mapping out persona journeys can allow the airport to create experiences that will serve the personal needs of different personas to make them all feel equally valued. Understanding the emotions and sentiments at each stage of the journey is key because the customer experience is almost always dictated by how people feel at a particular moment (Figure 4).

SOCIAL MEDIA ANALYSIS

Social media analysis is an increasingly popular tool being utilized to gain insight into the customer's perspective. It is the quantitative and qualitative analysis of social media and media data used to gain insights into customer preferences, attitudes, and behaviors. Organizations can triangulate social media data with other traditional data sources to gain a more in-depth understanding of the customer

experience. The information can be used to engage in conversations with customers, design less costly but more effective targeted interventions, and empower airport employees to incorporate data insights into their daily decision making.

Social media analysis is highly customizable to the specific and unique needs of individual organizations, and results can be used as metrics to evaluate the organization's performance on customer experience internally, as well as against other organizations across different industries. This technique can be used in an exploratory way to gain an overall understanding of where the airport stands in customer experience, but it also can be used in a targeted way to examine a specific need or issue the airport is facing (such as, wayfinding).

A limitation of social media is that certain customer segments, such as seniors, may not be well represented. This reinforces the importance of utilizing other methods of data collection to ensure all voices are captured.

IMPLEMENTATION OF PRACTICES

Implementation practices will be dependent upon available resources such as

budget, staffing and volunteers, time, and each individual organization's unique environment. Knowing which customer segments are targeted and what the desired outcomes are can enable organizations to identify their most relevant research findings.

Impact of COVID-19 on the Customer Experience

The transportation industry will always be vulnerable to external and internal shock events, with the aviation industry often experiencing the brunt of these. While history has shown that the transportation industry has always recovered from shock events, the acute impact of these events on the evolution of the industry and on individual organizations has sometimes been profound. The case of the COVID-19 pandemic is no different, and impact on the customer experience and beyond has been significant.

While the impact continues to be felt by the industry, organizations have evolved rapidly and effectively, particularly in regard to the customer experience. There is a much greater emphasis on basic needs—including safety and cleanliness—although at times this has been at the expense of other elements of the customer

experience. New technologies have been deployed rapidly to create a touchless environment. Organizations have enhanced communication and collaboration with their stakeholders, which translates to an improved experience overall. In the long run, many of the changes will be positive for the customer experience, particularly once customers have had the chance to adapt.

Conclusion

Organizations that think about what future customers will look like—and what their needs will be—will have a competitive advantage in preparation for emerging business needs and will be in a better position to increase their business growth and profitability.

This includes striving for a high level of cultural competency, social inclusion, and disability inclusion by meeting and exceeding the needs of diverse customers. Successful organizations tend to approach culture and inclusion from a broad perspective—in addition to meeting the needs of customers of diverse

nationality, organizations also should consider the needs of customers of different ages, genders, disability status, geographic locations, health conditions, and the like.

Organizations that attend to the expectations of each of these segments differently also are more likely to adopt innovative solutions with the help of technology and develop a higher level of cultural competence, as well as social and disability inclusion.

To better understand, prepare for, and meet the needs of diverse customers, organizations should strengthen their efforts toward having a more inclusive and diverse representation of employees. This will require a continued emphasis on hiring a diverse workforce to best serve the growing diversity of customer segments.

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VOLUNTEER VOICES

“ The earliest civilizations developed and flourished where the transportation system was well defined—generally rivers and waterways. Over time, roads, railroads, airports, and other modes were added to facilitate movement of people and goods. One of the most significant contributions of TRB is to bring transportation professionals, policy makers, researchers, academics, industry experts, and users from around the world under one roof to discuss transportation-related issues, share experiences and research results, learn from each other, and display technological advances that make the most efficient use of available resources. TRB has not only helped in expanding the knowledge base of the current generation of transportation professionals but also in educating and preparing the next generation to handle the challenges of today, tomorrow, and beyond.

—NAVNEET GARG

Program Manager, FAA National Airport Pavement and Materials Research Center
Atlantic City, New Jersey





Photo: wundervisuals, iStock

Does LED Roadway Lighting Affect Driver Sleep Health?

RAJARAM BHAGAVATHULA

The author is a research scientist at Virginia Tech Transportation Institute in Blacksburg.

Above: Traditional high-intensity discharge (HID) light sources are being replaced by light emitting diode (LED) technology, but do we know the impact of these replacements? Do LEDs with high blue content influence alertness or human health? Blue light in the wavelengths common in consumer electronics—such as tablets and monitors—is known to influence the circadian system and melatonin regulation. NCHRP Project 05-23 sought to determine if this is so in the roadway environment, and how much LED roadway lighting with high blue content it might take to make a difference in nighttime traffic safety.

Light emitting diode (LED) technology has revolutionized the lighting industry. The capabilities of these light sources, like dimming and instant-on (along with their high efficiency), have allowed lighting designers to overcome some of the limitations of previous technologies, particularly in roadway lighting environments. However, concerns related to the health and environmental impacts of LEDs have been raised. An American Medical Association report expressed concern regarding the blue content in the LED spectrum and its effect on circadian rhythms in humans (1). Despite these concerns, no controlled empirical studies have quantified the health effects of any part of the LED spectrum under real-world roadway lighting conditions.

Circadian Rhythms in the Industrialized World

The human body's 24-hour circadian rhythms are driven by light in the environment. Light also has powerful neuroendocrine and neurobehavioral effects,

including the regulation of melatonin, a hormone secreted by the pineal gland. These effects are mediated in part by light stimulation of the eye's intrinsically photosensitive retinal ganglion cells (ipRGCs) (2). For healthy circadian and neuroendocrine regulation, humans need exposure to sufficiently bright light during daytime and darkness at night. In modern industrialized nations, nighttime lighting on roadways and in outdoor spaces raises concerns that it disrupts normal sleep, circadian rhythms, and neuroendocrine physiology. Such disruptions have been associated with the risk of some cancers, heart disease, and metabolic disorders (3). The ipRGCs are most sensitive to blue light, with light in the wavelength range of 459 to 484 nanometers having the strongest effects on the circadian system and melatonin regulation (2, 4). LEDs typically have higher blue spectral content than traditional high-intensity discharge (HID) light sources. Exposure to LEDs in the evening has been shown to disturb circadian rhythms, resulting in sleep loss (5–6).

By contrast, there is evidence that light with a high blue content (such as light from LEDs) can increase alertness and enhance cognitive performance in humans (7–8) and, as a result, enhance nighttime traffic safety among drivers and pedestrians. To design effective roadway lighting, there is a growing need to understand the relationships between roadway light level, melatonin suppression, and driver alertness and health. However, these relationships had never been investigated in realistic roadway environments until the research undertaken in National Cooperative Highway Research Program (NCHRP) Project 05-23, "Effects of LED Roadway Lighting on Driver Sleep Health and Alertness." To inform roadway lighting standards that will reduce unintended negative effects of roadway lighting and improve driver alertness, it is critical to understand the effects of both spectral power distribution and light levels on human health and alertness.

The Research Effort

NCHRP Research Report 968: *LED Roadway Lighting—Impact on Driver Sleep Health and Alertness* documented the effects of different lighting types and their corneal illuminances on measures of drivers' sleep health and alertness (9). Sleep health was evaluated based on melatonin levels in saliva. Driver alertness was measured objectively using driver reaction time, percentage of time that a driver's eyelids are closed over a certain period of time (PERCLOS), and standard deviation in lane position (SDLP), as well as subjectively using the Karolinska Sleepiness Scale (KSS). This project filled a critical technological need by determining the effects of light type and level on driver sleep health and alertness. These results are expected to be highly relevant to the needs of state departments of transportation (DOTs) and will allow for informed, evidence-based decisions regarding light source and level.

To address the project goals, the research team conducted two experiments. The first measured illuminance dosage. The second assessed driver sleep health and alertness (DSHA).

Illuminance Dosage Experiment

The team measured the illuminance of a wide range of roadway lighting sources based on the spectral power distributions observed in realistic roadway conditions and from LED consumer devices.

For the naturalistic driving portion of the experiment, a member of the research team wore a personal light dosimeter (Figure 1) while driving an instrumented vehicle (2016 Ford Explorer) on the Virginia Smart Road, a closed test track that features lighting capabilities and other advanced research aids for transportation technology and safety research. The length of the driving portion was two hours during which the driver was exposed to different roadway lighting conditions.

In the consumer device exposure portion of the experiment, a personal light dosimeter and an illuminance meter measured the light from LED consumer devices (e.g., television, tablet computer, and mobile phone) under two separate conditions for the same duration of two hours. The experiment was conducted

in conditioning rooms where light from extraneous sources had been eliminated.

Daily exposure measurements also were recorded. Ten volunteers wore the personal light dosimeter for one day (24 hours) to determine the typical illuminance exposure received from light sources encountered on a daily basis. This task provided information on the range of corneal illuminance exposure during a typical 24-hour period.

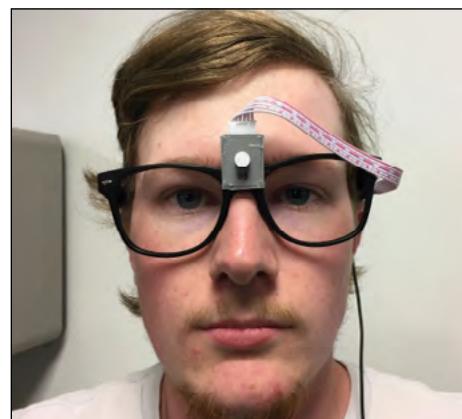


FIGURE 1 Personal light dosimeter developed at Virginia Tech Transportation Institute.



Photo: Courtesy of Rajaram Bhagavathula

Lights on and ready to roll, the vehicle (*at right*) is waiting to start a two-hour test run on a section of the Virginia Smart Road, one of the world's most advanced testing facilities for transportation technology and safety research. Managed by Virginia Tech Transportation Institute in cooperation with the Virginia Department of Transportation, this facility was used extensively to carry out the LED roadway lighting experiments under controlled conditions.

Results of the Illuminance Dosage Experiment

This experiment showed that the illuminance dosages from a continuous two-hour roadway lighting exposure were considerably lower than the illuminance dosages a person experienced in a 24-hour period or from a two-hour exposure to most of the consumer electronic devices tested (Figures 2 and 3). The most common LED light source used on U.S. roadways is the 4,000 K LED and a luminance of 1.5 cd/m² (candela per square meter) is 25 percent higher than the highest light level specified by the Illuminating Engineering Society's recommended practice for roadway lighting. The illuminance dosage from a two-hour exposure to a 4,000 K LED at a luminance of 1.5 cd/m² roadway lighting condition is approximately 0.1 percent of the total illuminance dosage experienced by daytime office workers (as measured in this study with a cumulative average illuminance dosage of 14,848,272.7 lux-s).¹

The highest illuminance (amount of light falling on a surface) dosage from a two-hour exposure to 4,000 K LED at luminance (amount of light being reflected from a surface) of 1.5 cd/m² (13,162.1 lux-s or 1.9 lux/s)² was lower than all consumer electronic devices except the iPad Pro (3,456 lux-s or 0.5 lux/s) and Kindle Paperwhite (12,456 lux-s or 1.5 lux/s) in dark mode for the same two-hour duration. This comparison assumes that a person is continually driving in a lighted section for a two-hour period, which is unlikely unless drivers in major cities are taken into account. By contrast, a two-hour exposure from a consumer electronic device is a common occurrence in today's society. Further, in order to get the same illuminance dosage from a 4,000 K LED at a luminance of 1.5 cd/m² roadway lighting condition as from a two-hour exposure to a computer monitor or a television in dark mode, a person has to experience that roadway lighting condition for 17.8 and

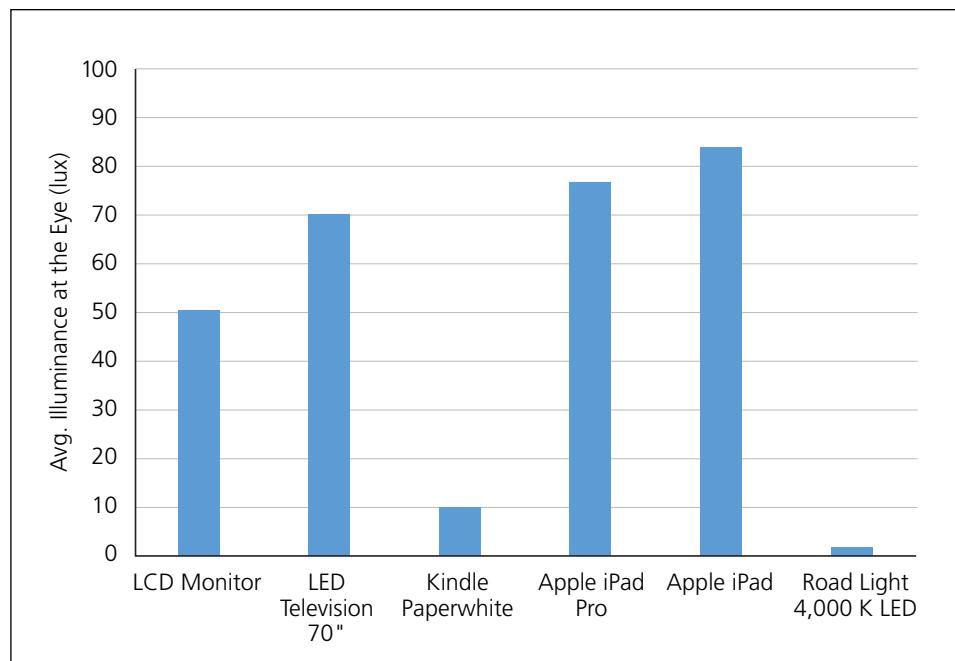


FIGURE 2 Illuminance dosage from consumer electronic devices compared to 4,000 K LED roadway lighting when the consumer devices were in full brightness mode.

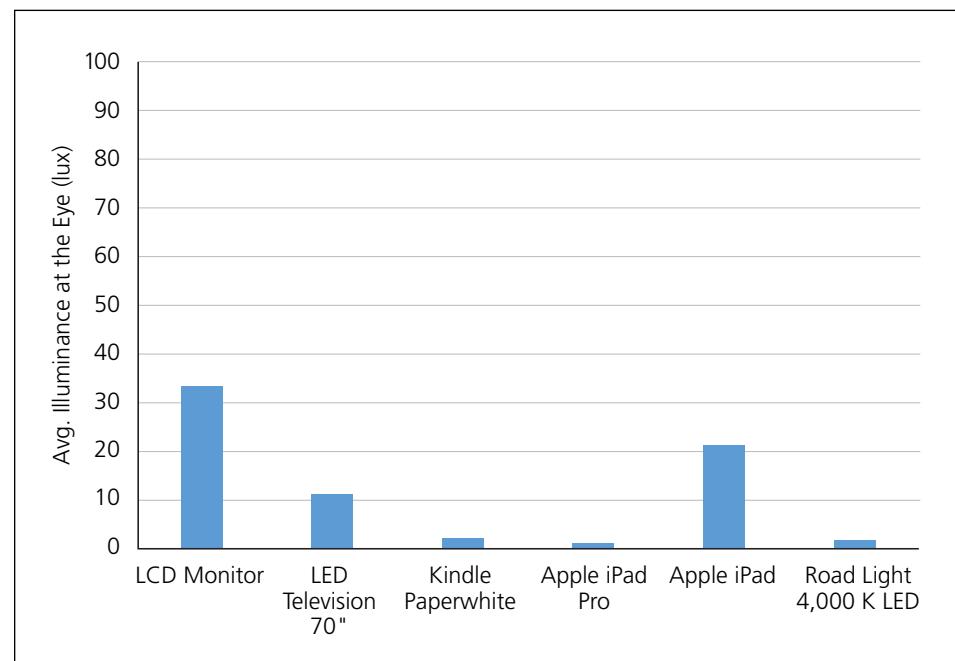


FIGURE 3 Illuminance dosage from consumer electronic devices compared to 4,000 K LED roadway lighting when the consumer devices were in dark/night mode.

5.7 hours, respectively. The potential for melatonin suppression from consumer electronic devices like televisions, monitors, and tablets is considerably higher than for LED roadway lighting. This is

supported by published research showing that light exposure from e-readers at 31.73 lux (6) and LED computer monitors at less than 100 lux (5) significantly suppress melatonin.

¹ Lux-s is the cumulative intensity of light on a surface for a given period of time, two hours in the case of this study.

² Lux/s is the intensity of light on a surface per each second.



Photo: Becca Tapert, Unsplash

Driver Sleep Health and Alertness Experiment

The DSHA experiment assessed the effect of an LED roadway lighting type at several illuminances on subjective and objective measures of driver sleep health and alertness. The goal was to determine the corneal illuminance that produces a measurable effect. The same objective and subjective measures of driver sleep health and alertness were measured for a positive control (only melatonin levels measured), a negative control (no roadway lighting), and a traditional HID source (a single illuminance matched to that of an LED source).

To assess driver sleep health, melatonin levels in saliva were measured. Since sufficiently bright exposure to light can suppress melatonin, melatonin levels can serve as a quantitative index related to sleep health.

Driver alertness was determined objectively by measuring reaction time, PERCLOS, and SDLP, as well as subjectively based on KSS. The DSHA experiment included 10 healthy, publically recruited male and female volunteers between ages 18 to 30. The participants were exposed to outdoor lighting environments at light levels based on recommended practice, as well as higher-than-recommended practice light levels produced on the Virginia Smart Road.

The participants drove two identically instrumented 2016 Ford Explorers equipped with data acquisition systems that collect kinematic data from the vehicle's controller area network system. Data collected included vehicle speed, differential GPS coordinates,

If that glow from your tablet or other electronic device keeps you awake at night, it may be more than the topic of your search or the conversation that causes sleeplessness. Bright light, especially within the blue range of the spectrum, can suppress the release of melatonin, a hormone that regulates sleep.

video images (e.g., driver's face, forward roadway, left side of roadway, and right side of roadway), audio from the driver, manual button presses, a lane tracker to determine vehicle position within the lane, and input from the in-vehicle experimenter.

Three roadway lighting types were evaluated (Table 1). The most common LED light source currently used for lighting roadways in the United States is the 4,000 K LED. The traditional HID roadway lighting source is the high-pressure sodium (HPS) 2,100 K HPS. These two light sources have different spectral power distributions, which allowed the researchers to assess the impacts of spectral power distribution on the objective and subjective measures of driver sleep health and alertness. The third lighting type was a no-roadway-lighting condition, which was used as a negative control.

Three light levels were identified based on the light levels that are achievable on the Virginia Smart Road and the Illuminating Engineering Society's standard specified light levels (10). A high light level of 1.5 cd/m² average luminance was selected, which is 25 percent higher than the average luminance specified for major streets with high pedestrian activity classification (1.2 cd/m²) and 50 percent higher than the average luminance specified for expressways (1.0 cd/m²). The 1.2 cd/m² measurement is the highest light

level recommended by the Illuminating Engineering Society for any kind of roadway. A medium light level of 1.0 cd/m² and a low light level of 0.7 cd/m² were selected and could be achieved across all pavement types on the Virginia Smart Road. The HPS lighting matched the highest light level of the 4,000 K LED, rather than the lowest light level.

Participants were recruited from the public to be tested under the selected experimental conditions. In the positive laboratory control, a high-intensity 4,000 K LED luminaire at close range was used to suppress the dim light melatonin onset and peak melatonin secretion. Positive control laboratory studies of nocturnal melatonin secretion served as reference points to compare the melatonin levels in the experimental driving scenarios on the Virginia Smart Road. The objective of the positive control was to strongly suppress the earlier melatonin onset and peak melatonin secretion. After completing the control testing, the realistic lighting scenarios were carried out by exposing participants to each of the test conditions while they drove on the Smart Road. During the exposures, participants' melatonin levels were quantitatively determined at 30-minute intervals. In addition to melatonin levels, participants' reaction time (measured by detection distances of objects on the roadway), PERCLOS, SDLP, and self-reported measures of drowsiness using KSS also were measured at 30-minute intervals to gauge driver alertness. Increased alertness increases driver reaction time and, in turn, lengthens the distance at which drivers can detect objects on the road. Increased PERCLOS and SDLP are associated with higher driver drowsiness.

TABLE 1 The DSHA Experiment's Independent Variables and Values

Independent Variable	Levels
Light Condition	2,100 K HPS – High (1.5 cd/m ²) 4,000 LED – High (1.5 cd/m ²) 4,000 LED – Medium (1.0 cd/m ²) 4,000 LED – Low (0.7 cd/m ²) No Roadway Lighting – (less than 0.5 cd/m ²)
Exposure Time	1 to 3 A.M. (Five saliva samples collected at 30-minute intervals)

Note:

HPS = high-pressure sodium

LED = light-emitting diode

Participants arrived at the test facility at 11 p.m., where they were exposed to 200 lux of typical indoor residential lighting for two hours. From 1 to 3 a.m., participants were exposed to the positive control or the experimental roadway lighting conditions on the Virginia Smart Road. Saliva samples were collected every 30 minutes. Between light exposures, a gap of at least one week was provided so that participants could go back to their usual sleep schedule.

Results of DSHA Experiment

The results showed that neither the 4,000 K LED roadway lighting (at high, medium, or low levels) nor the 2,100 K HPS-High lighting condition had an effect on salivary melatonin suppression (Figure 4). Numerous studies have demonstrated melatonin suppression as a result of light exposure in laboratory conditions using monochromatic light sources (4, 11–12) or broadband white sources at very high light levels of 1,000 lux and higher (13). Therefore, light exposure from any of the roadway lighting conditions—at the highest level of 1.9 lux from 4,000 K LED-High—was not strong enough to elicit a detectable salivary melatonin suppression for drivers who experienced the two-hour exposure from 1 to 3 a.m. Statistically significant differences were observed only between the positive salivary control study performed in the laboratory and all of the roadway exposure conditions. The melatonin suppression observed in the positive laboratory control study employed a bright white light ($1,000 \mu\text{W}/\text{cm}^2$; 3,500 lux) not typically encountered on roadways at night. The Illuminating Engineering Society recommends the highest street lighting of $1.2 \text{ cd}/\text{m}^2$ (10). Two of the tested street lighting conditions exceeded this luminance by 25 percent ($1.5 \text{ cd}/\text{m}^2$). The highest average measured subject illuminance during exposure to the four different electrical street lighting conditions ranged from 1.1 to 1.9 lux. The average measured participant corneal illuminance during exposure to driving conditions with no roadway lighting was 1.4 lux. The current study demonstrates that the relatively dim exposures from all of the tested

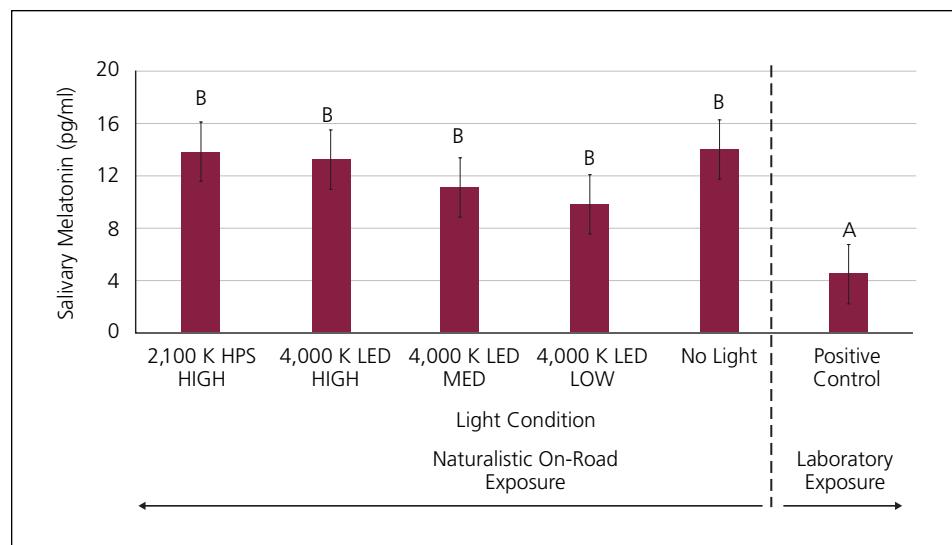


FIGURE 4 Effect of light condition on salivary melatonin. (Note: Values are least square means of melatonin. Error bars denote standard errors. Conditions with the same letters indicate no statistical differences in salivary melatonin suppression.)

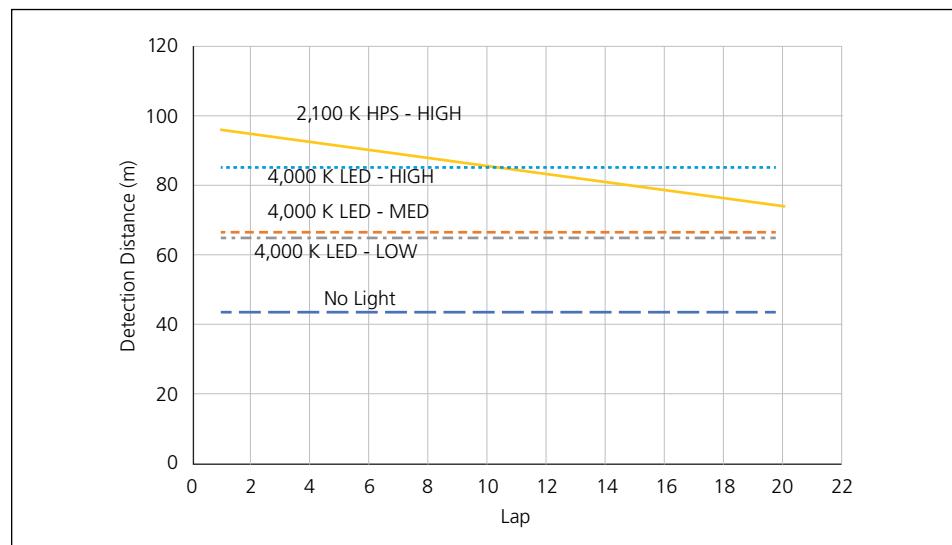


FIGURE 5 Effect of the number of roadway track laps on detection distance for each of the light conditions.

roadway lighting environments for drivers do not suppress salivary melatonin.

Increasing the light level made it easier to detect objects on the roadway from greater distances (detection distance). Under the 2,100 K HPS-High lighting condition, both detection and color recognition distances showed a decrease the longer the participants were exposed (Figure 5). Such decreases in visual performance with increase in exposure time were not observed across any of the 4,000 K LED conditions or the no-roadway-lighting condition. The decrease in detection and color recognition distance

under the 2,100 K HPS-High lighting condition could be attributed to fatigue as a result of the relative nonuniformity of the 2,100 K HPS (uniformity ratio = 7.5) over the 4,000 K LED (uniformity ratio = 4.0). A nonuniform roadway lighting condition, like 2,100 K HPS-High, has a higher number of darker and lighter bands than a more uniform roadway lighting condition, like 4,000 K LED. A longer exposure to alternating darker and brighter bands of nonuniform lighting can fatigue a driver more than uniform roadway lighting conditions. More research is required to understand if greater exposure time to the

2,100 K HPS decreases driver performance. PERCLOS and SDLP were not affected by any of the roadway lighting conditions. With respect to PERCLOS, on average the participants' eyes were closed approximately 30 percent of the time for all roadway lighting conditions and times. This shows that in all of the roadway lighting conditions—including no roadway lighting—participants exceeded the 12 percent eye closure threshold that is associated with moderate or greater drowsiness based on existing research (14–16). This result shows that under all exposure conditions, participants were equally drowsy. There were no statistical differences in the KSS scores of any of the road lighting conditions from 1.1 to 1.9 lux, and the no-roadway-lighting condition at 0.8 lux. KSS scores in the road conditions were higher than in the positive control. This indicates that, no matter what the light level, drivers were sleepier in the road exposure conditions than in the positive laboratory control. These results show that neither the spectral power distribution of the light source nor the light level in the roadway lighting conditions significantly affected objective and subjective measures of driver alertness.

Conclusions

Overall, the study results show that LED roadway lighting does not significantly affect driver salivary melatonin and subjective and objective alertness from 1 to 3 a.m. Although the results indicated a decrease in visual performance for the 2,100 K HPS light source, those results were not confirmed by other objective measures (such as PERCLOS and SDLP) or subjective measures of alertness like KSS scores. Major differences in melatonin suppression and subjective alertness were observed between the positive laboratory control and all of the roadway lighting conditions. Also, no meaningful inferences could be made on the effects of gender on melatonin suppression or measures of alertness. These results show that illuminance dosages that affect salivary melatonin and subjective and objective alertness are much higher than those experienced on typical roadway lighted environments.

The application of roadway lighting needs should be considered in terms of several different aspects affecting the road user and the built environment. These different aspects of the roadway lighting system include safety, energy conservation, road-user acceptance, impact on user health, sky glow and light trespass, and impact on the surrounding ecology. This project primarily considered the impact on user health, roadway safety (using visual performance as a surrogate), and alertness. The results show that the spectral content and the intensity of the roadway lighting do not affect salivary melatonin suppression or alertness in the human participants. As a result, spectral power distribution of the light source is not likely to influence the health of roadway users, particularly drivers. The light dosage on the roadway is too low to elicit a measurable effect. However, the other consideration of roadway lighting spectrum and intensity is its effect on flora and fauna at or near the roadway, and these considerations need to be included in any recommendations (17–19). Future research on the use of adaptive lighting techniques—the lighting system dims or brightens in reaction to the needs of roadway users—is needed to determine how much additional energy savings this technique provides and if it reduces the negative impact of the lighting spectrum and its intensity on the surrounding ecology.

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Photo: An Errant Knight, Wikimedia Commons

Working Together to Improve Bus Stops

TODD HANSEN

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Above: A Utah Transit Authority (UTA) bus is ready to offload and pick up passengers at the Meadowbrook TRAX Station in South Salt Lake City. The master agreement between UTA and Salt Lake City is an example of agreements that improve bus infrastructure and solidify relationships between transit agencies and other entities.

Bus stops—and the pathways to reach them—are the initial gateways to fixed-route transit service. Usually, transit agency customers who want to use fixed-route transit service first must walk or ride to the bus stop, then wait for the bus to arrive. Sometimes those pathways are perfectly wide and clear of obstructions, and the shelter waiting area provides temporary comfort and security before the bus ride.

Often, however, many bus stops in the fixed-route system need maintenance or replacement amenities at the bus stop site. Additionally, pathways and sidewalks to reach stops may not be complete or may have obstacles such as cracks in the pavement, treacherous slopes, or intersections and crosswalks that are unsafe to traverse. Bus stops with poor amenities or incomplete sidewalks can be particularly difficult to use for people with disabilities and ultimately may make the bus service inaccessible to these and other users.

Typically, state or local governments have jurisdiction over the streetscapes

where bus stops are placed, including the sidewalks, curb cuts and ramps, and intersection crossings. Although most transit agencies can make improvements to the immediate bus landing pad area, improvements to the connecting sidewalk must be approved by the controlling jurisdiction—often along with funding support. Some pathway areas may be limited in width or may involve easement and platting issues with businesses and private property owners, with whom it can be tough for transit agencies to coordinate and agree on infrastructure improvements.

Additionally, development or utility construction projects in or near transit service areas can occur without awareness of or input from the transit agency. These are missed opportunities to make improvements that are harmonious—and cost effective—with goals for accessible transit stops.

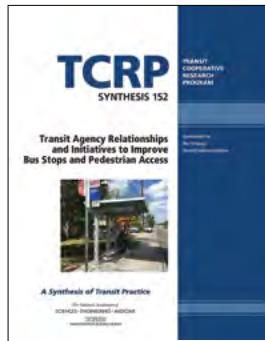
All transit agencies with fixed-route bus services have an intrinsic interest in providing quality infrastructure for users to access the bus. In an ideal funding and

jurisdictional environment, transit agencies would be able to fund and construct improvements at all bus stops and the connecting pathway infrastructure. However, because of limitations in available funding and right-of-way (ROW) under other entities' control, transit agencies need to be able to make informed decisions and work with other organizations on bus stop and pathway improvements that provide the highest benefit toward agency goals, systematically improving all stops in the fixed-route system over time.

Project Approach

This study on bus stop improvement programs at transit agencies was conducted in three phases: 1) a literature review on bus stop and connecting pathway infrastructure and existing improvement programs, 2) an online survey targeting transit agencies with identified programs, and 3) case examples of transit agencies with interesting or unique practices.

The objective of the research and its resulting report, *Transit Cooperative Research Program (TCRP) Synthesis 152:*



To read *TCRP Synthesis 152: Transit Agency Relationships and Initiatives to Improve Bus Stops and Pedestrian Access*, visit <https://dx.doi.org/10.17226/26166>. A companion webinar is available at <https://onlinepubs.trb.org/onlinepubs/webinars/210921.pdf>.

Transit Agency Relationships and Initiatives to Improve Bus Stops and Pedestrian Access, was to provide useful information on the state of the practice in improving bus stops and connecting pathway infrastructure while showcasing the benefits and challenges of improvement programs with interagency relationships, agreements with other entities, and working with private parties.

The study team focused information-gathering efforts around relationships and communication between the transit agency and other local entities or groups, including governments, developers, nonprofit organizations, and the general public. The survey questionnaire and case example discussions centered on key topics identified during the literature review, including the following:

- Scope of the bus stop improvement program;
- Infrastructure elements included in the program;
- Tools, processes, and data elements used in the program;
- Improvement program agreements with local public or private entities;
- Communication and coordination with other entities;
- Americans with Disabilities Act of 1990 (ADA) accessibility and equity considerations;
- Funding sources and mechanisms for infrastructure improvements;

Definition of Terms

The following key terms for bus stop and pedestrian infrastructure were used in this study and the resulting synthesis:

- **Shelter.** A curbside amenity designed to provide protection and relief from the elements and a place to sit while patrons wait for the bus.
- **Bench.** Standard seating for riders waiting at the bus stop, typically located underneath the shelter, on the landing pad, or both.
- **Landing Pad.** An unobstructed, level, and paved area (at least 5 by 8 feet) that is provided for bus patrons and can connect to a bench or shelter, connected to the pedestrian pathway.
- **Rear-Door Area.** An additional firm-surface area located adjacent to the rear door of the bus, connected to the standard landing pad area and pedestrian pathway.

• **Pathway.** The pedestrian path to get to and from the landing pad serving the bus stop, preferably using a paved, continuous, and level sidewalk to ensure accessibility and ease of use for all riders.

• **Crossing.** Designated place for pedestrians to cross a street at an intersection or midblock, typically with markings on the road and pedestrian signals.

• **Curb Ramp.** A short ramp at a street intersection, cutting through a curb or built up to it, designed to safely transition from a roadway to a curbed sidewalk.

• **Lighting.** Overhead lighting at the bus stop area either on, or adjacent to, the landing pad. Adequate lighting is important for customer comfort, safety, and security.

• **Detectable Warning.** Distinctive surface pattern of truncated domes on a curb ramp, detectable by cane or underfoot, to alert a pedestrian of the approaching street crossing.

- Measured outcomes or benefits from the programs; and
- Key challenges and lessons learned.

Responses and Case Examples

Researchers sent the survey questionnaire to transit organizations across the United States, targeting agencies with identified bus stop improvement programs or agreements (Figure 1). The survey respondents provided information on program history, structure, and lessons learned, including aspects of project management, goals and prioritization, design standardization, coordination with regional entities, and public input and communication. Some transit agencies also provided examples of their agreements with local municipalities, state departments of transportation (DOTs), or other public and private entities that helped facilitate their improvement programs.

The study team and project panel reviewed the survey questionnaire responses and identified several transit agencies with interesting practices for inclusion as in-depth case examples. Agencies invited to participate as case example participants represented different geographic settings, sizes, and governmental structures around the United States. One case example was developed with a regional focus to include information from different transportation agencies concerned with bus stop improvements.

The following agencies provided several lessons from their experiences with infrastructure improvement programs and agreements with local partners:

- Athens–Clarke County Transit in Athens, Georgia;
- Regional Transportation Authority (RTA), Chicago Transit Authority, and Pace in the Chicago, Illinois, region;

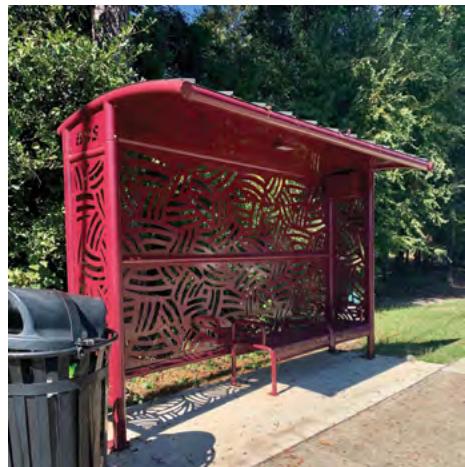


Photo courtesy Cruglez Stermann Studio

Form meets function in Athens, Georgia, where—between 2005 and 2020—Athens–Clarke County Transit has combined the Bus Stop Improvement Program with arts programs to make transit more enjoyable for everyone. To date, artists have designed 44 theme-based bus shelters. Artist Rosa Cruz followed a traffic and street theme to design the “Tight Route” shelter.



FIGURE 1 Map of survey respondent locations. (MPO = Metropolitan Planning Organization; COG = Council of Governments; AOG = Association of Governments.)

- San Francisco Municipal Transportation Agency (SFMTA) in San Francisco, California;
- Utah Transit Authority (UTA) in Salt Lake City; and
- VIA Metropolitan Transit in San Antonio, Texas.

Key Findings

Although practices on improvement programs vary from agency to agency, the study team found several areas of recurring themes for agency perspectives on important issues and best practices for improving bus stops (Figure 2). Some key findings from the survey responses, as well as case examples highlighted from the report, follow.

COMMON PROGRAM GOALS

For nearly all transit agencies, improving bus stop accessibility is the most desired outcome for their improvement programs, along with making more bus stops in the fixed-route system ADA compliant. Other common goals mentioned in survey responses include improving the comfort and safety of customers getting to and waiting at the stop, as well as responding to improvement requests from the community.

Most transit agencies also focus on improving fixed-route ridership through bus stop improvements. Agencies will monitor ridership on an ongoing basis and sometimes will conduct before-and-after analyses to assess how improvements affect ridership.

JURISDICTIONAL CONTROL

Information about jurisdictional control at or around the bus stop area came from multiple question prompts in the survey and case example information; this includes whether transit agencies have an infrastructure element in their improvement programs for all of their stops or for only some of their stops because of jurisdictional or property limitations, or both.

Most transit agencies include a landing pad at all their bus stops, and benches and shelters are included at some bus stops in the system. Because of right-of-way issues, pathway components to reach the bus stop are less often part of agency programs.

For more than two-thirds of survey respondents, limited right-of-way was cited as the key issue for transit agencies when working with developers and including agency interests in developments and construction. Another key issue from respondents was the

inaccessibility of existing slopes of sidewalks and pathways, requiring extensive construction or reconstruction (presenting jurisdictional and funding challenges for agencies to tackle).

DEDICATED FUNDING

Funding poses a persistent challenge for transit agencies that wish to make system improvements and conduct maintenance. It is important for the agency to establish a dedicated funding source (such as federal or state funding) for bus stop and pedestrian infrastructure improvements.

Programs detailed in the survey responses often do not rely on a single source of funding. Instead, they specifically use mixtures of local funding, such as contributions from cities and businesses, as well as advertising revenues. Working with municipalities to communicate the importance of such improvements also can generate support for regular or intermittent local funding for improvements, while making citizen feedback an integral part of the process.

CUSTOMER INPUT AND EDUCATION

Customer input and education were key for successful programs to create bus stop access improvements that provided better benefit to riders. Community meetings, postings at bus stops, and online announcements are regular tools used for communication with the public. Some transit agencies make a particular effort to work with organizations in the disability community and low-income communities to inform improvement needs, ensuring that bus stops are improved in the places of highest need.

In California, SFMTA uses its equity plan to target shelter improvements and other initiatives to areas of high need in the city. In Utah, UTA has established a committee that meets regularly on accessibility needs for service.

DATA AND PRIORITIZATION

Several transit agencies use index processes and prioritization systems as consistent and transparent methods for decision making and as justification of

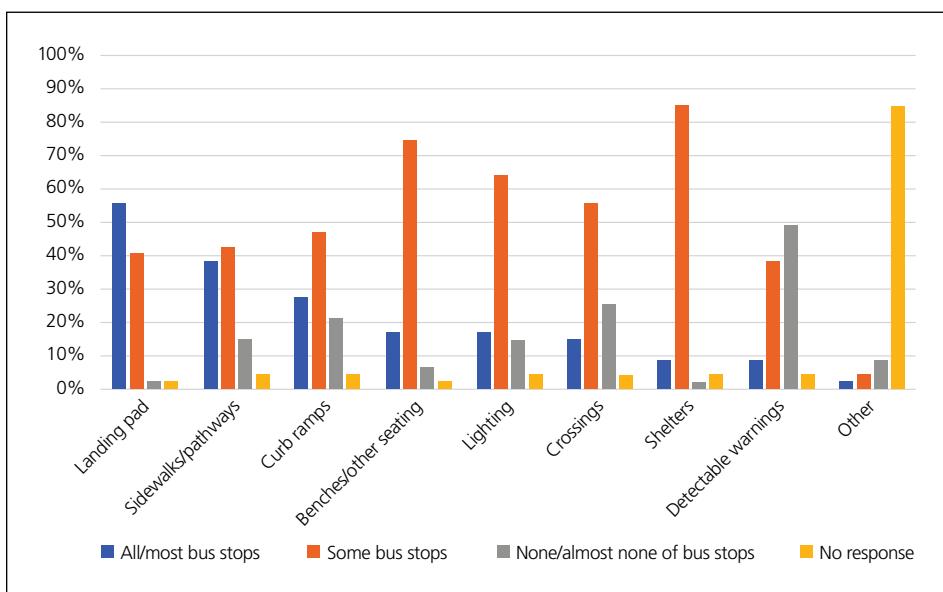


FIGURE 2 Survey responses to the following question: “Indicate which infrastructure elements are included in your transit agency’s bus stop and pedestrian infrastructure improvement program.”



Photo: Seattle DOT

In 2017, the Seattle DOT in Washington State cohosted a neighborhood transportation forum with the Roosevelt Neighborhood Association to identify engineering strategies to make NE 65th Street safer for pedestrians, cyclists, transit riders, and drivers. Community members presented concerns and ideas, looked at traffic data, and discussed strategies to lower vehicle speeds and reduce crashes on the roadway.

improvement placement based on the factors of transit use and community need. These mechanisms can be used with combinations of quantitative and qualitative data sources that are tied to agency and community goals.

Fixed-route ridership was the most frequently cited measurement used for prioritization, while some agencies used additional data points—such as condition

of amenities, customer and staff input, and adjacent land uses—to go beyond rider-only prioritization. Making connections between service schedule, ridership, amenities, and maintenance data can support decision making on infrastructure improvements on an ongoing basis.

Three of the case example agencies shared their prioritization systems for the report (Table 1).

TABLE 1 Utah Transit Authority Bus Stop Scoring Matrix

Category	1 Point	2 Points	3 Points	4 Points	5 Points
Non-ADA Compliant	–	–	–	–	Yes
TSA per Average Daily Weekday	1–19	20–39	40–59	60–79	80+
Total Annual Bus Ramp Deployments	1–49	50–99	100–149	150–199	200+
Transfer Point					
Equal to or Greater Than 30-Minute Frequency	1 Route	2 Routes	3 Routes	4 Routes	5+ Routes
Less Than 29-Minute Frequency	1 Route	2 Routes	3 Routes	4 Routes	5+ Routes
Serves Title VI Community	Title VI Route/Area	–	–	–	–
Safety					
Intersection					
Parking Allowed	1 of 5 Elements	1 of 5 Elements	1 of 5 Elements	1 of 5 Elements	1 of 5 Elements
Obstacle(s) Present					
No Lighting Present					
Sidewalk Not Level					
Social					
Education-Adjacent	Yes	–	–	–	–
Library-Adjacent	Yes	–	–	–	–

NOTE: ADA = Americans with Disabilities Act of 1990; TSA = total stop activity. (Source: Adapted from *2019 Bus Stop Master Plan*, Utah Transit Authority.)

MAINTENANCE AND STANDARDS

The topic of standards for amenity designs—such as those for bus stop shelters and seating—came up frequently during case example conversations, since these standards are helpful for agencies to enhance consistency in infrastructure installation, maintenance, and useful life. Standards also can help justify different levels of amenities at different locations in the fixed-route system based on usage data. In addition to design standards, an updated bus stop inventory database, tracking maintenance information, and dedicated staff members who focus on bus stop upkeep and repair are best practices for bus stop improvements.

LEADERSHIP AND COORDINATION

The departments in charge of bus stop improvement programs, as well as collaborators within and outside of the agencies, can vary greatly between transit agencies.

Planning departments most commonly act as program leads, but other common examples can include capital improvement departments and project management offices. Transit agencies also get support for improvement programs from facilities, operations, maintenance, and community outreach staff.

Additionally, the most successful programs foster relationships with external entities. Building relationships and coordinating with other local public entities and developers require a proactive process to include transit issues in the local conversation and to embed transit improvements as a part of new developments. This process includes communication with local planning departments at the city and county level to ensure that the jurisdictions served incorporate the bus service network and necessary bus stop improvements into their planning processes.

Piggybacking and Packaging

Many transit agencies cited a strategy of grouping bus stop and pathway improvements with other projects as a way to coordinate improvements and save on total financial costs. Strategies include piggybacking bus stop improvements with larger projects and packaging smaller bus stop improvements together to create larger projects.

In their communication with other local government agencies, transit agencies can piggyback their desired bus stop improvements—such as new landing pads or completed sidewalks—with other local streetscape or corridor projects. The same can be done with utility or private development projects. This coordination helps incorporate bus stops with local infrastructure projects in a cost-effective manner, sometimes at reduced or no capital costs for the transit agency.

Similarly, packaging small bus stop improvement projects together, either within a transit system or across different communities, can help create a larger overall project that is more competitive with some federal funding opportunities. RTA's Access to Transit Program in the greater Chicago region was specifically designed to group small alternative transportation projects together in communities outside the main city, which has helped improve access to Pace service.

Local Partnerships and Agreements

Formal agreements with other partners can help solidify support, define responsibilities, and create more permanent revenue sources and ease of implementation for improvements. Transit agencies also can use agreements to gain jurisdiction over bus stop shelter areas, designate responsibilities for infrastructure maintenance, or specify the funding requirements of local partners tied to bus stop improvement projects.

The study team received several examples of agreements concerned with bus stop infrastructure from responding transit agencies, including master use agreements, performance resolution agreements, and



Before



After

Source: Regional Transportation Authority

Improvements to the crosswalk to reach a Pace bus stop in the greater Chicago, Illinois, area include a crossing, curb cuts, detectable warning bumps where the sidewalk transitions to the street, and pathways.

funding support or match agreements. UTA's Master Agreement with Salt Lake City is included as an appendix in *TCRP Synthesis 152*.

Final Takeaways

Each case example in the synthesis report highlights notable practices, challenges, and lessons learned from participating transit agencies. Limited right-of-way was cited frequently as a challenge in working with developers and attempting to include transit agency interests in upcoming developments and construction projects. Agencies also stressed that having common goals and processes for the program and among coordinating organizations is important for staying on track with bus stop improvements. Without these in place, it is difficult to rally diverse stakeholders together and earn community buy-in. Because of funding challenges, transit agencies also struggle with ensuring equity of improvements and balancing demands from high-ridership and high-density corridors.

Researchers determined several best practices that transit agencies can incorporate into their own bus stop and pathway improvement efforts. Coordinating improvements into larger corridorwide or areawide projects ties transit needs to city projects, reduces total capital costs,

and encourages coordination with other local entities for ease of implementation. Packaging small improvement projects together makes projects more competitive in funding and gives projects in smaller cities a better chance to succeed.

Agencies need to be proactive in building relationships and coordinating with other local organizations, even on an informal basis when formal agreements are not established. Index process and prioritization systems establish transparent methods for improvements and can move beyond ridership-focused decision making. Finally, it is important that barriers to making improvements in low-income or marginalized communities are addressed proactively and removed to ensure equitable use of infrastructure investments.

Acknowledgments

The author thanks the team members that helped with this research: Kelly Blume, Jinuk Hwang, and Ipek Sener. The author also thanks all of the transit agency staff members who responded to survey questionnaires, as well as those who provided additional time and information for the case examples in the synthesis.

Where Speed Limits and Safety Intersect



Photo: noelsch, Pixabay

JENNY O'CONNELL

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To set speed limits in the United States, federal regulation recommends that traffic engineers follow the lead of the fastest drivers on the road. Researchers in the 1960s recommended setting the speed limit at a street's 85th percentile operating speed (the speed of the third fastest driver out of 20) under the assumption that drivers will always travel at reasonable speeds for conditions. But evidence from across the country shows that drivers base their decisions at least partially on the posted speed limit. When the speed limit rises and drivers see the resulting increased speed of their peers, they drive faster too, which results in increased speeds on the street overall (1).

Speed's Inequitable Toll

This status quo speed limit setting approach contributes to thousands of deaths every year on U.S. roads. According to the National Highway Traffic Safety Administration, 9,478 people died in speed-related crashes in 2019, which accounts for more than a quarter of all traffic

fatalities across the country (2). For people walking and biking—who do not benefit from in-vehicle safety features such as seatbelts and airbags—a vehicular speed increase of even a few miles per hour creates an exponentially risky scenario. A person hit by a car traveling at 35 miles per hour is seven times more likely to die than a person hit at 20 miles per hour (3).

In the United States, pedestrian fatalities have been on the rise for a decade, reaching consecutive all-time peaks in 2019 and then again in 2020—two years with dramatically different traffic volumes (4). A recent study found that nearly all of the nation's most dangerous streets for pedestrians are designed for speed: 97 percent have three or more through-lanes, 70 percent have five or more through-lanes, and three-quarters have speed limits of 30 miles per hour or higher (5).

Compounding the problem, a long history of structural racism in urban and transportation planning, manifested in redlining, gentrification, and underfunding of urban streets, means that many of these

Above: Even on a quiet morning in New York City's Chinatown, vehicles, pedestrians, bicycles, and delivery vehicles must coexist in the same space. How safely they do so is influenced by many factors, including the posted speed.

dangerous, high-speed roads are predominantly in neighborhoods with low-income residents and high proportions of people of color. Crash data from across the United States emphasizes the inordinate impact of poorly designed streets on historically marginalized communities: Black, Indigenous, and other people of color constitute a disproportionate number of pedestrian fatalities (6).

Using a Safe Systems Approach to Reduce Fatalities

Other industrialized countries have proven that fewer traffic deaths and safer roads are possible, a notion with which the U.S. Department of Transportation (U.S. DOT) agrees (7). Rather than focusing on individual behavior, these countries focus on changing the policies and engineering decisions that create unsafe conditions. This technique, also known as a safe systems approach, is the guiding philosophy behind the safer streets in the European Union and Norway, which—as shown in Figure 1—have, on average, a per capita traffic fatality rate that is half and one-third, respectively, of that in the United States (8).

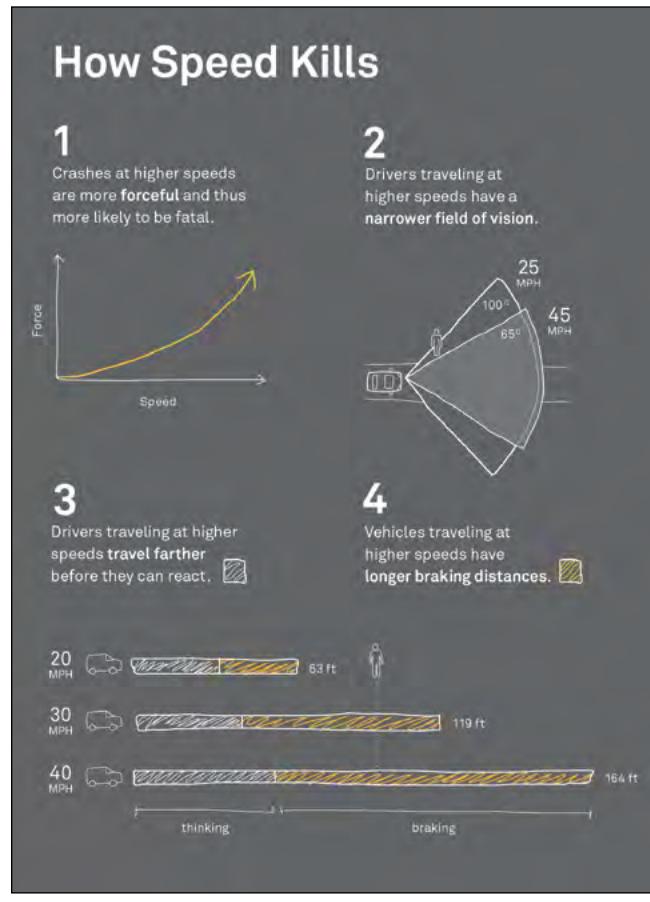


FIGURE 2 Speed kills in four significant ways.
(Source: NACTO.)

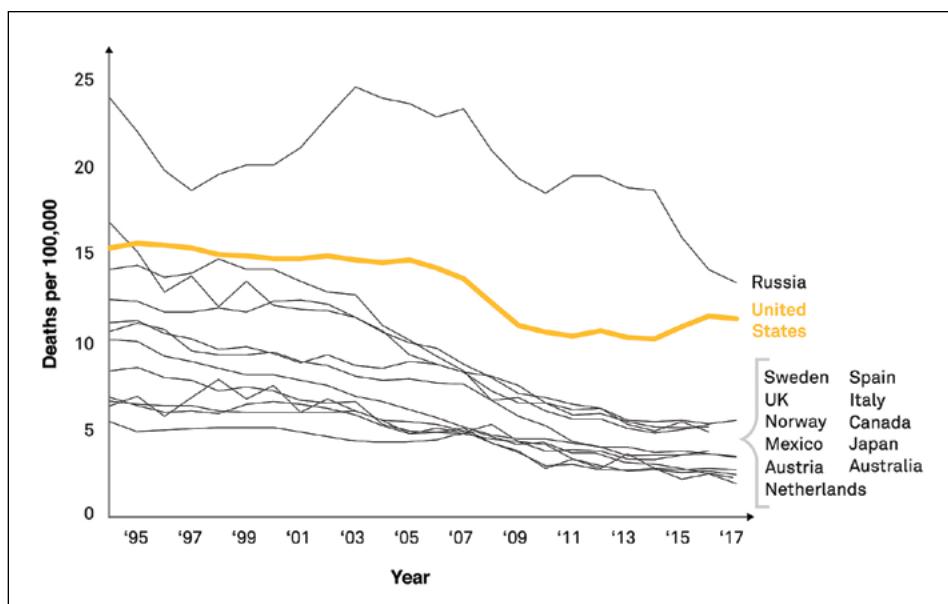


FIGURE 1 Data from other countries show that fewer traffic deaths are possible. Traffic fatalities are declining in most industrialized countries, but rising in the United States.
(Source: NACTO.)

Reducing vehicular speeds is the most important tool that transportation practitioners have for keeping people safe. The *Highway Safety Manual* reports that a 1 mile per hour reduction in operating speeds can result in a 17 percent decrease in fatal crashes (9). A separate study found that a 10 percent reduction in the average speed resulted in 19 percent fewer injury crashes, 27 percent fewer severe crashes, and 34 percent fewer fatal crashes (10). Higher speeds also increase the likelihood of a crash happening at all by creating conditions in which drivers have less peripheral awareness than they do at lower speeds (11); travel farther between the time when they see another vehicle, person, or obstruction and hit

the brakes (12); and brake over a longer distance (Figure 2) (13).

Percentile-based speed limit setting methods exacerbate these issues and fail to manage speeds because they set a permanently moving target based on current human behavior, not safety. The following two issues are at play:

- Percentile-based models are designed to respond to extremes. When enough people drive faster than the set percentile, the model reacts by instructing traffic engineers to increase the posted speed.
- People decide how fast to drive based on the street's design and cues, such as the posted speed and other drivers' speeds (see Figure 3, Page 40).

To reduce traffic fatalities on U.S. roads, a safe systems approach is needed. Enter the City Limits guidance from the National Association of City Transportation Officials

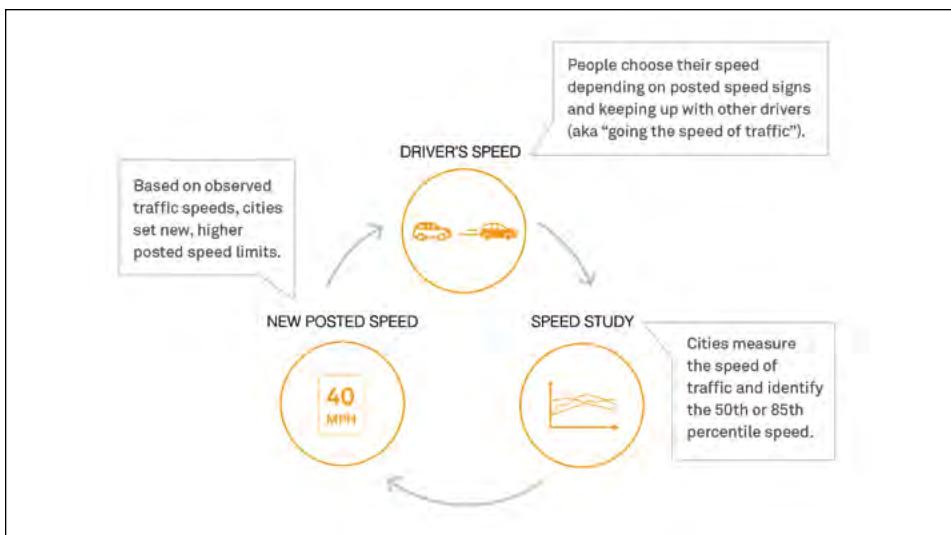


FIGURE 3 Percentile-based speed limit setting methods fail to manage speeds because they are tied to a permanently moving target based on current human behavior rather than safety. (Source: NACTO.)

(NACTO), which employs a safe systems approach for speed limit setting by instructing practitioners to evaluate a street's conflict density (how frequently potential conflicts arise) and activity level (how active a street is or is expected to be) to determine the maximum safe speed limit (14).

Built on real-life experiential data on how people move on urban streets, as opposed to an outdated model developed for rural, limited-access roads, the guide notes that where conflict is likely, crash risk rises. And as speeds rise, crashes are more likely to be fatal. The result? High-conflict, high-activity streets should have the lowest speed limits, while less active, less conflict-prone streets can tolerate slightly higher speeds. For most urban streets, this means speed limits of no higher than 25 miles per hour for major streets and often indicates speed limits of 20 or even 15 miles per hour where there is significant modal mixing.

The benefits of reducing speed limits are already apparent in cities across North America. A growing body of research shows that speed limit changes alone can lead to measurable declines in overall speeds and crashes, even absent of enforcement or engineering changes. For example, a 2017 study in Boston found that just reducing the citywide speed limit to 25 miles per hour from 30 miles per hour reduced speeding overall and

dramatically decreased the instances of high-end speeding (vehicles traveling faster than 35 miles per hour) (15). Similarly, in Canada, researchers found measurable safety gains after Toronto lowered speed limits from 40 kilometers per hour (about 25 miles per hour) to 30 kilometers per hour (about 20 miles per hour) on some local streets (16). Recent efforts in Portland and Seattle underscore this pattern. In Portland, researchers found that a speed limit reduction from 25 to 20 miles per hour on residential streets resulted in a 25 percent reduction in vehicles traveling more than 10 miles per hour over the speed limit, and a 48 percent reduction in vehicles traveling more than 15 miles per hour over the speed limit (17). The Seattle Department of Transportation saw significant speed and crash reductions when they lowered the speed limit to 25 miles per hour and increased the density of speed limit signs on select streets (18).

In addition to having a direct impact on dangerous speeding, reducing the posted speed limit unlocks a variety of engineering and design tools that can further increase safety on a street and support other policy goals. Typically in urban areas, the posted speed aligns with the design speed, dictating the infrastructure and safety elements that can be included in the final street

design. For example, the AASHTO *Green Book* includes a formula for the minimum curve radius, which is a function of the designated design speed (19). In practice, that means that if the design speed is 30 miles per hour, a wider curb radius will be required than if the design speed is 20 miles per hour. But the wider curb radius enables faster turns and increases exposure and risk for people walking and biking (Figure 4). In the end, the result is that all too often, essential pieces of safety infrastructure are ironically ineligible for inclusion in a street redesign because drivers are currently going too fast. In effect, the street is too dangerous to build safety infrastructure.

Drawbacks of Percentile-Based Tools for Setting Speed Limits

With mounting evidence about the safety drawbacks of using the 85th percentile approach to set speed limits, some practitioners offer FHWA's online speed limit setting tool, USLIMITS2, as a better alternative. While USLIMITS2 does, theoretically, allow practitioners to consider factors other than operating speeds when setting limits, the tool still fundamentally relies on a percentile-based approach to setting speed limits, which is proven to result in higher speeds over time.

The recently published *National Cooperative Highway Research Program (NCHRP) Report 966: Posted Speed Limit Setting Procedure and Tool—User Guide* also continues to rely on operating speeds as the basis for a street's speed limit, even when there is a history of crashes and an abundance of multimodal activity (20). Rather than catalyzing speed limit reductions, a history of crashes and the existence of multimodal activity merely serve to prevent the tool from recommending a *higher* speed limit. One of the report's case studies presents an urban collector with high pedestrian activity, 25 fatal and serious crashes over a five-year period, and a 30 miles per hour posted speed. Despite such a significant crash history, the tool recommends a speed limit of 30 miles per hour, a number derived solely from the existing 50th percentile speed of the street. But evidence

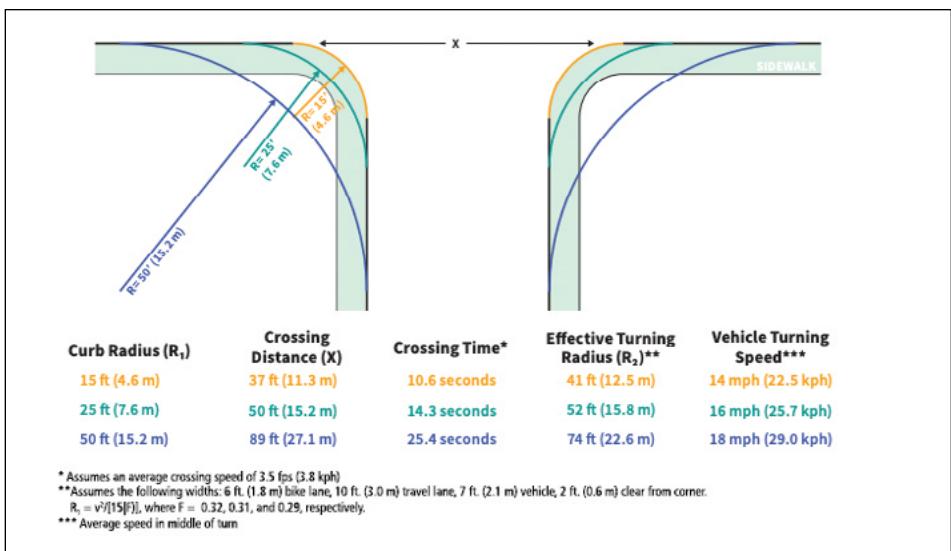


FIGURE 4 Design speeds often dictate design features. Note how reducing the curb radius slows turning movements and protects people crossing the street. But if engineers are required to maintain higher speeds in accordance with the design speed, they are prevented from narrowing corner curb radii and bringing down speeds. (Source: Alta Planning and Design.)

shows that a 25 miles per hour—or even 20 miles per hour—speed limit would be much safer and more appropriate on a collector street in an urban core. Despite years of study, these tools continue to fail road users by tethering decisions about how fast all drivers should be traveling to the behavior of individual drivers.

Getting Everyone from Point A to Point B Safely

In October 2021, after years of rising fatalities on U.S. roads, U.S. DOT announced a National Roadway Safety Strategy rooted in the safe systems approach (7). This shift is long overdue, and marks an important milestone in the prioritization and implementation of safety in the transportation system. For cities, reducing posted speed limits in line with safety goals is at the core of a safe system for all road users. Lowering speed limits creates opportunities for safer street designs, unlocking space and improving comfort for people walking, biking, and riding transit. A transportation system that enables people to walk, bike, and ride transit safely also supports other critical city policies around equitable access, economic sustainability, and carbon emissions reductions. Everyone deserves to get from Point A to Point B safely, and

the entire transportation system must play a role in making that happen. By using a safe systems approach for designing, managing, and operating U.S. roadways, transportation practitioners can achieve streets that are safe, healthy, and sustainable for all road users.

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Determining the Posted Speed Limit

New Tool Applies Decision Rules for Existing Speed Limit-Setting Practices

KAY FITZPATRICK

The author is a senior research engineer at the Texas A&M Transportation Institute in College Station.

Several factors are considered within engineering studies when determining the posted speed limit for a speed zone. National Cooperative Highway Research Program (NCHRP) Project 17-76, "Guidance for the Setting of Speed Limits" investigated the factors that influence operating speed and safety and used that knowledge to develop the Speed Limit Setting Procedure (SLS-Procedure) so engineers can make informed decisions about setting speed limits. The SLS-Procedure was automated with the Speed Limit Setting Tool (SLS-Tool), which uses spreadsheet-based software.

The research team considered the breadth of approaches available for setting speed limits and the need to develop a methodology that could be used for any roadway type. They selected a decision-rule-based procedure for the SLS-Procedure (Figure 1). Given the increased emphasis on designing for the context of the roadway, the research team decided that the SLS-Procedure should be sensitive to context and use the expanded functional classification scheme available in *NCHRP Research Report 855: An Expanded Functional Classification System for Highways and Streets* (1). The roadway types and roadway contexts available within the expended functional

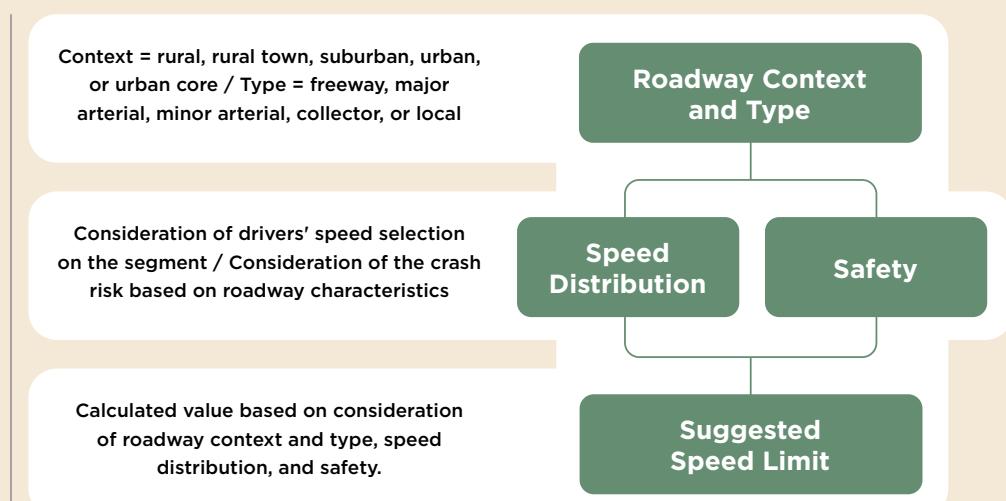


FIGURE 1 Overview of the procedure to calculate the suggested speed limit.

classification scheme were collapsed into four speed limit setting groups (SLSGs), which included limited access, undeveloped, developed, and full access.

For the SLS-Procedure, the research team recommended consideration of the measured operating speed as the starting point for selecting a posted speed limit. However, they also noted that the measured operating speed should be adjusted based on roadway conditions and consideration of the crash experience on

the segment. The SLS-Procedure starts with identifying the roadway segment context and type, which determine the appropriate SLSG. For that SLSG, the roadway characteristics and crash potential for the segment are used to identify the speed distribution that should be considered and whether the closest five miles per hour-increment value or a rounded-down five miles per hour-increment value should be used. Unique decision rules were developed for each SLSG.



Photo Courtesy of Texas A&M Transportation Institute

What determines the speed limit for a road like this collector in Texas? Engineers can use the Speed Limit Setting Procedure and Tool to guide them in setting speed limits that reflect site context, characteristics, speed data, and crash history.

NCHRP Project 17-76 concluded with the development of the following two publications:

- *NCHRP Research Report 966: Posted Speed Limit Setting Procedure and Tool—User Guide* (2) and
- *NCHRP Web-Only Document 291: Development of a Posted Speed Limit Setting Procedure and Tool* (3).

The SLS-Tool also is downloadable with or without macros on the TRB website.¹ It includes the following three worksheets:

- **Instructions worksheet** provides an overview of the SLS-Tool.

¹ The NCHRP 17-76 SLS-Tool can be downloaded with or without macros from <http://www.trb.org/main/blurbs/182038.aspx>.

- **Analysis worksheet** is used to enter input data and obtain analysis results. Key cells are color-coded to indicate the type of data entered or displayed, and a legend is included.

- **Support tables worksheet** contains several tables that are used in the analysis calculations. The values can be changed, but only if based on agency policy or new knowledge (i.e., new research, extensive local data, and so on).

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VOLUNTEER VOICES

“In the transit field, TRB brings together quantitative as well as qualitative information on what different transit agencies are doing regarding a specific topic that would never be gathered comprehensively otherwise. This provides invaluable compare-and-contrast analyses between agencies and indicators of what works most effectively. It also provides valuable insights—especially in relatively new fields like mobile ticketing or microtransit—that can help agencies that are considering these new technologies.

—ED PARK

Senior Transit Planner
Regional Transportation Commission of Washoe County
Reno, Nevada



Frances Harrison

Chief Technical Officer, Spy Pond Partners

Frances Harrison is a strong believer in the value of transportation research. She arrived at the Massachusetts Institute of Technology (MIT) at age 16 and, soon after, was drawn to civil engineering's systematic and quantitative approach to analyzing real world systems. The broad impact of transportation systems on so many aspects of daily life and the multidimensional nature of transportation problems was compelling. After earning a master's degree in civil engineering with a transportation focus from the University of California, Berkeley, in 1980 she returned to Massachusetts to work at Cambridge Systematics, which Harrison describes as "a small, MIT spinoff in the heart of Kendall Square where less than 20 people worked." They were doing exactly the kind of work Harrison wanted to do: applying systematic analysis to transportation problems, including innovative approaches to system management. "Everyone was super smart and dedicated," Harrison observes. "The firm became my family for the next 25 years."

During this time, Harrison worked on a wide range of transportation topics: paratransit, special needs transportation, variable work hours, transit operations, traffic operations, parking and downtown transportation management, corridor planning, capital programming, maintenance and asset management, and transportation performance management. She had the opportunity to try database application development and admits, "I had very little coding background, but I jumped in with both feet (hands?), and learned to program. This was a welcome break from writing reports. It felt like doing puzzles and gave me a good foundation for my later work on data and information management."

In 2005, Harrison and another Cambridge Systematics colleague realized they wanted greater flexibility and autonomy. Together, they formed Spy Pond Partners, a consultancy headquartered in Arlington, Massachusetts. "This was a difficult decision, but it turned out to be the right one," she explains. "It has been

enormously satisfying to build a successful and impactful practice while being a part of advancing transportation asset, performance, and information management practices for clients, as well as at the national level."



"Lack of good data, information, and knowledge management impacts everything that agencies are trying to do."

Harrison acknowledges that recently she has worked less on substantive topics—how to plan, design, operate, and maintain transportation facilities and services—and more on how transportation organizations manage their data, information, and knowledge. "I think I gravitated to this place because I recognized through my earlier work that there is a huge payoff from getting the data, information, knowledge management part right—and a huge downside to ignoring it." She notes that she has seen transportation agencies go through cycles when they are operating well in a particular area, but these same agencies backslide when staff or management changes. "I have seen many agencies

held back because they don't have good information to guide their decisions. Some are challenged to get their information systems modernized and integrated," she adds. "Lack of good data, information, and knowledge management impacts everything that agencies are trying to do."

Harrison has led or contributed to more than 20 Transportation Research Board (TRB) projects covering foundational topics such as cross-asset investment tradeoffs, performance targets, transportation data interoperability, and transportation data governance. She has been a member of many TRB committees. She chaired the Standing Committee on Information Systems and Technology from 2010 to 2016 and the Task Force on Knowledge Management from 2017 to 2020. She is the current chair of the NCHRP Project Panel on Implementing and Leveraging Artificial Intelligence and Machine Learning at Departments of Transportation, as well as the co-chair of the Standing Committee on Information and Knowledge Management.

The research that has tantalized Harrison most in her career looks at an organization to determine what is happening, why, and how to do better. Helping agencies figure out how to get the information they need and use it effectively, as well as how to create ways to identify and share critical knowledge that will help agencies improve over time rather than backslide, is a puzzle that Harrison never tires of putting together. "At age 17, I chose transportation as a profession because I was drawn to its multidisciplinary, multidimensional nature and the opportunity to apply systems thinking. Decades later, while I couldn't have predicted the trajectory of my career, these are still the same things that keep my interest."

Her advice to young professionals? "Find people who inspire you, and try to work with them. Keep learning, get out of your comfort zone, and surprise yourself with what you can do. And get involved in TRB—it's a great way to learn and build professional relationships."

Jane Lappin

Principal, Lappin Consulting

Jane Lappin recognizes the importance of giving back to the community that so generously fostered her growth and set her career on the path she continues to navigate. Today, amid a work portfolio filled with business consulting and international research and development, she makes time for volunteer projects that advance safe and accessible automated mobility and chairs the board of a philanthropy that supports a South African public health and education nongovernmental organization called Mpilonhle. Lappin happily notes that her Transportation Research Board (TRB) leadership commitments play a significant role in this portion of her career.

In 1991, after working for a corporate strategy consulting group, leveraging her experience with survey research methods and a recently earned master's degree in business administration from Simmons College in Boston, Massachusetts, Lappin joined the U.S. Department of Transportation's John A. Volpe National Transportation Systems Center as one of their few social scientists. "As luck would have it, my hiring coincided with the passing of the ISTEA [Intermodal Surface Transportation Efficiency Act of 1999] legislation that authorized the new Intelligent Vehicle-Highway Program, which would later be renamed Intelligent Transportation Systems (ITS)." When Volpe assembled a panel of national transportation authorities to guide the development of the cross-modal ITS program, Lappin was the junior staffer who supported these experts. "Within the year, we wrote the ITS Joint Program Office (JPO) into existence," she recalls. "That original document guided the ITS JPO through its first two decades." Looking back, she realizes that she had no idea at the time, but this was the start of her lifelong career in transportation research.

In the years that followed, Lappin led consumer and market research programs, developed ITS public-sector marketing strategies, evaluated the impact of ITS devices and systems on traveler demand, and helped to establish and served as secretariat to the ITS international research working groups with the European Commission, Japan, South Korea, Canada,



"Since TRB convenes across sectors and internationally, it is an ideal destination for testing new ideas."

and Australia. She repeatedly experienced how good research data provided the foundation for sound policy and investment recommendations. For example, consumer research demonstrated that drivers would not consult traffic information kiosks before embarking on trips—but transit riders highly valued bus arrival information. "These insights helped direct program funds away from low-value services that would have little impact on personal mobility and funneled them to higher impact services that improved transit rider satisfaction and increased ridership," Lappin explains.

After more than 20 years at Volpe, a U.S. Department of Transportation Secretary Gold Award, and a U.S. Department of Transportation Secretary "Partnering for Excellence" Team Award, Lappin took a nonlobbying position as director of public policy and government affairs for the Toyota Research Institute in Los Altos, California. She provided leadership for global automated vehicle (AV) policy and regulatory trends that focused on system safety,

social equity, and highway operations. As a spokesperson for AV technology, testing, and operations, Lappin was the company point person for accessible-by-design initiatives and contributed to Toyota's global AV safety assurance strategy with the United Nations Economic Commission for Europe where, she notes, "much of the world's automotive and roadway safety regulations are formed."

Today, one of Lappin's international projects has her working with transportation researchers at Delft University of Technology in the Netherlands. Their research aims to model the "herd immunity" traffic safety impact of highly automated vehicles on the surrounding human-driven vehicles. "Given that AVs will have superior crash-avoidance capabilities, human drivers of vehicles around an AV will receive traffic safety benefits," Lappin explains. She also is working on Hi-Drive, a large pilot project assessing the impact of highly automated vehicles on European public roads.

Throughout Lappin's career, TRB has been a constant. Her first TRB Annual Meeting in 1993 "was overwhelming and exhilarating. As a newcomer, I met generous experts who provided constructive peer review, which was—and continues to be—central to my professional development. With each subsequent year's Annual Meeting, my understanding of the transportation enterprise deepens." Lappin's involvement fostered professional collaborations and led to publications, new research projects, and the development of workshops to address ITS. She found her niche at the newly formed Standing Committee on Intelligent Transportation Systems, which she chaired from 2010 to 2017. She co-founded and continues to lead the Automated Road Transportation Symposium, co-chairs the Forum on Preparing for Automated Vehicles and Shared Mobility, and serves as chair of the Standing Committee on Vehicle-Highway Automation.

"Since TRB convenes across sectors and internationally, it is an ideal destination for testing new ideas," she states. "I can't imagine my career without TRB at the center of it."

INFLUENCER

TRANSPORTATION



Majbah Uddin

Majbah Uddin is R&D associate staff in the Transportation Analytics and Decision Sciences Group at Oak Ridge National Laboratory in Oak Ridge, Tennessee. He is the chair of the Freight Systems and Marine Group Young Members Coordinating Council and a member of the Standing Committee on Intermodal Freight Transport and the Standing Committee on Freight Transportation Data.

He also serves as a member of the National Cooperative Highway Research Program (NCHRP) project panel on Integrating Resiliency into Transportation System Operations.

How did you first hear about and become involved in TRB?

I first heard about TRB when I was a graduate student at the University of South Carolina. My Ph.D. supervisor encouraged me to submit a research paper to the Annual Meeting. Since 2015, I have attended the Annual Meeting each year. I participated in committee and subcommittee meetings, contributed to activities, presented research papers, and expanded my research network.

How has TRB influenced your career so far?

TRB has had a very positive impact on my academic and professional career. During my graduate studies, I presented my research during numerous Annual Meetings and received feedback from experts. This helped guide my research in the right direction. TRB also has enhanced my professional networking and leadership skills. During one Annual Meeting, I was selected to participate in the TRB Freight and Marine Mentoring Program, where I was paired with a mentor who is an expert in my research area. I learned how to navigate the annual program, become more involved with committee activities, and foster effective networking with peers.

What was one of your most memorable TRB Annual Meeting moments?

During the 2019 Annual Meeting, I went to the Convention Center to be part of the group photo taken for the TRB Centennial Celebration. I am very happy to be in such a historic photo with transportation leaders and experts.

Transportation Influencer highlights the journey of young professionals active in TRB. Have someone to nominate? Send an e-mail to TRNews@nas.edu.

Let's Hear from You!



In each issue, we pose a sometimes light and fun transportation-related question that allows you to share your thoughts with other readers. To answer, [click here](#) or e-mail us at TRNews@nas.edu and follow these simple steps:

1. In the subject line, include “**Volunteer Voices: [the question you’re answering]**”;
2. Answer the question thoughtfully, but keep it brief—up to about 150 words;
3. Add whether you are a TRB member or volunteer, and list the committees you are involved with; and
4. Add TRNews@nas.edu to your contacts so we avoid your spam folder when we tell you you’re going to be published.



That's it! Like all TR News content, your response may be edited for grammar, length, and TRB style. When the issue with your quote is published, you'll get a PDF of the page featuring your response and photo.

Now that you have the details, here's the question:
What is the funniest experience you've had at a TRB Annual Meeting?

International Trade and Transportation Committee Wins First Blue Ribbon Award for Diversity



Previously, the Technical Activities Council has granted Blue Ribbon Awards to standing committees in the areas of identifying and advancing ideas for research; contributing to improving the management and operation of TRB committees; moving research ideas into transportation practice; and attracting and preparing the next generation of TRB professionals and scholars. The purpose of these awards is to recognize the exemplary best practices of standing committees and the volunteer efforts associated with those activities. The committees receiving a Blue Ribbon Award serve as models, with committee chairs and members acting as role models who share their experiences with others.

In 2021, a new award—the Blue Ribbon Award for Diversity—was created to recognize committees that use innovative strategies to increase the diversity of their membership and friends, especially from groups that are historically underrepresented in transportation research and practice (e.g., African-American/Black, Hispanic/Latino, Native American, Native Alaskan, Native Pacific Islander, and women).

The first award for diversity, presented at the 2022 TRB Annual Meeting, went to the Standing Committee on International Trade and Transportation. Committee Chair Juan Carlos Villa of Texas A&M Transportation Institute describes the committee's scope—which includes convening experts to develop solutions to issues related to regional, national, and international trade



Technical Activities Council Chair Avery Grimes (right) presents Juan Carlos Villa, chair of the Standing Committee on International Trade and Transportation, with the 2021 Blue Ribbon Award in the Category of Diversity for *Best Practices in Attracting and Retaining Members and Friends from Historically Underrepresented Groups*.

and transportation—as one that “lends itself to attracting diverse researchers and practitioners based on race/ethnicity, gender, and national origin. The committee also attracts those interested in multiple transportation modes, disciplines, and other areas of interest or skill sets.”

In past years, the committee’s leadership implemented a strategy of attracting a diverse group of researchers and practitioners to become members and friends and to create an inclusive environment among those populations. Their strategy includes supporting members from historically underrepresented groups in transportation research and practice to take on prominent committee roles. As a result, the majority of the leadership roles

in the committee are filled with members from underrepresented groups; more than half of the committee’s membership are female, non-white, or both; and nearly half of its friends identify as Hispanic, African-American, or Asian/Pacific Islander.

To ensure retention of both members and friends, committee leadership carefully listens to their needs and interests and, Villa notes, “most of the committee’s decisions are discussed with members to develop events where participation of a large group of diverse stakeholders is encouraged.” The committee’s leadership also has a successful history of seeking out researchers and practitioners from minority groups as panelists and presenters of its sponsored activities.

In the future, committee leadership will continue implementing its diversity strategy by “identifying young minority researchers and practitioners interested in international trade and transportation at various events that the committee participates in,” Villa explains. This will include the Annual Meeting, regular meetings and webinars, and meetings and events sponsored by other TRB committees.

To learn more about the Standing Committee on International Trade and Transportation, visit its website at www.trbtradetransportation.org and consider becoming a friend of the committee by going to <https://www.mytrb.org/Committees/SelfNominationAsFriend>.

CONSENSUS REPORT 341

Looking Ahead at the FAA Cybersecurity Workforce

DANIEL TALMAGE AND BRENDAN ROACH

Talmage is a program officer on the Board on Human-Systems Integration in the Division of Behavioral and Social Sciences and Education at the National Academies of Sciences, Engineering, and Medicine in Washington, D.C. Roach is a program officer on the Computer Science and Telecommunications Board in the Division on Engineering and Physical Sciences at the National Academies of Sciences, Engineering, and Medicine in Washington, D.C. Both served as co-study directors for this project.

Cybersecurity in transportation is of utmost importance to any organization that is a part of the transportation industry. To help meet the future cybersecurity needs of FAA, Congress called on the National Academies of Sciences, Engineering, and Medicine to convene a study to examine FAA's cybersecurity workforce challenges, review its current strategy for meeting those challenges, and recommend ways to strengthen their cybersecurity workforce. The congressional request asked the National Academies committee to include workforce size, quality, and diversity in their considerations. Such diversity is critical in analyzing cybersecurity problems and widely understood to be a "functional imperative" for effective cybersecurity programs.

The study findings are documented in *Looking Ahead at the Cybersecurity Workforce at the Federal Aviation Administration*, a 2021 National Academies consensus study report that provides insight into the agency's current challenges in building its cybersecurity workforce and recommendations to ensure the future success of FAA's cybersecurity opera-



Photo: WOCinTech Chat, Flickr

Preparing to out-think future cyberadversaries takes a cybersecurity workforce of sufficient capacity and capability, bolstered by its diversity of backgrounds, skills, views, and experiences. Diversity is critical in analyzing cybersecurity problems.

tions. While FAA's current cybersecurity workforce is roughly on par with industry trends for diversity and has proven capable of meeting the agency's current needs, technological change and structural pressures make the issue of cybersecurity workforce development a critical one for FAA leadership. With better use

of existing programs for talent recruitment and adoption of proven practices to build a diverse talent pipeline, FAA can ensure that it will continue to meet the cybersecurity challenges of the 21st century.

SHORT SUPPLY OF QUALIFIED PROFESSIONALS

The report discusses that cybersecurity professionals are highly sought after and competition among employers for the limited talent pool is likely to grow more acute. Despite many initiatives to address the cybersecurity workforce imperative, the nation still faces a significant shortage of qualified cybersecurity professionals. Recruiting talent is particularly severe in the public sector because federal agencies must compete with private-sector firms that often provide better compensation. In addition to this wage pressure, FAA has further unique requirements for its cybersecurity workforce, such as the need for employees to have a deep understanding of a highly specialized mission and technology infrastructure, as well as an



Find the consensus study report at <https://www.nap.edu/catalog/26105>.

ability to defend against both cyber and physical safety and security threats. As FAA faces challenges in hiring new talent due to lower public-sector wages, it also faces a future wave of retirements among its cybersecurity workforce. Like many federal agencies, a significant portion of FAA employees is, or soon will be, eligible for retirement. This means that within a relatively short timeframe, FAA may have to replace a significant portion of its cybersecurity workforce amid increasing competition for talent and ensure that the agency can retain the highly specialized, mission-specific knowledge of its retiring cybersecurity workforce.

As discussed in Chapter 5, Key Challenges and Opportunities, FAA has a variety of opportunities to find more candidates. These include scholarship opportunities that pair students with public-sector organizations for internships and postgraduate employment and spot-hiring accommodations that provide agencies with flexibility to pursue in-demand talent outside the usual hiring process. In the future, FAA should be more effective in recruiting a cybersecurity workforce of sufficient capacity and capability in the face of competition for cybersecurity talent. Other reasons to recruit will be to replace the potential wave of retirees and the need for greater diversity in FAA's cybersecurity workforce.

TACTICAL ADVANTAGE OF A DIVERSE WORKFORCE

Cybersecurity as a discipline incorporates a broad range of skills and knowledge. An effective cybersecurity workforce will need to be diverse across several axes. This includes traditional diversity strategies, such as increased engagement of underrepresented minorities and women, as well as encouragement of applicants from a range of different educational institutions, previous employers, and geographic locations. Adversaries present a changing set of threat activities that challenge the imagination. To manage these tactics, cybersecurity professionals from diverse backgrounds who represent a range of views and skill sets are required as a critical part of the workforce. Greater

diversity represents an opportunity to grow the talent pool, which will allow FAA to keep pace with other organizations that have made diversity a recruitment priority.

By replicating existing efforts in other federal agencies, FAA can make significant gains in improving cyber-recruitment and bolstering its diversity. For instance, the popular Scholarship for Service Program helps connect cybersecurity students to federal employers and facilitate summer internships and employment after graduation. Partnerships at the institutional level also can foster the creation of a robust cybersecurity talent pipeline. Here, too, other federal agencies have established models that FAA can adopt, including developing centers of academic excellence and scholar-in-residence programs and collaborating in the development of specialized curricula and educational material.

FAA also can learn from effective private-sector practices. Mirroring private-sector trends that have bolstered the role of chief information security officers (CISOs), FAA may consider providing

the CISO role with more authority and access to agency leadership to foster an organizational culture in which cybersecurity professionals can be more effective in identifying and directing responses to cybersecurity challenges.

Some small changes to the ways in which FAA presents itself and manages its existing workforce can lay the foundation for recruiting a strong cybersecurity workforce. For example, FAA could create enhanced job fair materials and compelling job descriptions that highlight a work environment that combines cybersecurity operations with a unique mission. The agency also can emphasize current efforts to reskill workers to equip them to perform cybersecurity functions. Given the wide range of skills relevant to its cybersecurity practice, reskilling current employees—including current cybersecurity staff, noncybersecurity information technology staff, and operations staff—can provide FAA with a more readily available talent pool of future cybersecurity professionals.

COOPERATIVE RESEARCH PROGRAMS NEWS

U.S. Airport Industry Adoption of Automated Ground Vehicle Systems

As the entity with primary responsibility for ground vehicle permitting and activities on nonmovement areas, airports are responsible for defining requirements, systems, and minimum standards that enable and support tenants and other airport users to safely implement automated ground vehicle systems (AGVS) on airport property.

Quantitative Scientific Solutions has been awarded a \$450,000, 19-month contract (ACRP Project 10-32) to create a framework that addresses industrywide challenges and local airport issues while

providing the U.S. airport industry with a consistent and standardized approach to the adoption of AGVS. The contract also includes a playbook written for individual airports, scalable for airports of all sizes, and organized according to progressive phases for implementation.

For further information, contact Matthew J. Griffin, TRB, at 202-334-2366 or MJGriffin@nas.edu.

UPDATE FOR ACRP REPORT 99: GUIDANCE FOR TREATMENT OF AIRPORT STORMWATER CONTAINING DEICERS

ACRP Report 99 offers a process to help airports identify, select, and implement technologies for treating stormwater affected by deicing materials. At the time of its publication in 2013, the report contained new and emerging technologies and practices.

Many of these treatment options are now commonplace, which affords an opportunity to provide lessons learned, identify new technologies, and develop new airport deicer treatment system summaries.

Gresham Smith has received a \$150,000, 12-month contract (ACRP Project 02-96) to update *ACRP Report 99: Guidance for Treatment of Airport Stormwater Containing Deicers* to reflect the latest information on deicer treatment technologies, designing and implementing treatment systems, and determining costs associated with deicer treatments.

For further information, contact Joseph Navarrete, TRB, at 202-334-1649, or JNavarrete@nas.edu.

HANDBOOK ON DETERRING AND EXCLUDING BATS FROM TRANSPORTATION STRUCTURES

When state departments of transportation (DOTs) need to repair or replace transportation structures, they must take measures to avoid and minimize impacts on bats if protected species are present.

Environmental Solutions and Innovations received a \$499,965, 38-month contract (NCHRP Project 25-63) to develop a handbook for state DOT environmental staff and design and maintenance engineers on how to select and implement

methods to temporarily deter and/or exclude bats from transportation structures. The handbook will describe methods that are sensitive to the biological needs of bats and effective for a range of geographical locations, project types, and site conditions. The research will include field evaluations with a focus on nonlethal ultrasonic acoustic devices and other methods.

For further information, contact Ann Hartell, TRB, at 202-334-2369 or AHartell@nas.edu.

ARTIFICIAL INTELLIGENCE OPPORTUNITIES FOR STATE AND LOCAL DEPARTMENTS OF TRANSPORTATION

State and local departments of transportation (DOTs) are asked to solve ever more complex transportation problems and issues. Artificial intelligence (AI) is being proposed and implemented to help address a number of these issues, such as improving safety, alleviating traffic congestion, assisting in real-time systems management, accommodating connected/automated vehicles, preserving the infrastructure, improving organizational efficiency, and customer service.

Virginia Polytechnic Institute and State University has received a \$200,000, 18-month contract (NCHRP Project 23-12) to develop *Artificial Intelligence Opportunities for State and Local Departments of Transportation—A Research Roadmap* to identify and prioritize research needs that will provide state and local DOTs with a better understanding of AI, what activities are suited for AI, and the potential ways AI could be applied.

For further information, contact Sid Mohan, TRB, at 202-334-1249 or SMohan@nas.edu.

RACIAL EQUITY, BLACK AMERICA, AND PUBLIC TRANSPORTATION

Thrivance Group was awarded a 15-month, \$249,883 contract [Transit Cooperative Research Program (TCRP) Project H-59] to document the extent of damage that has been done to Black communities as a result of transportation decisions and actions, demonstrate

a methodology to estimate how much it would cost to redress those damages, and provide tools for elected officials and other stakeholder groups to engage effectively in the arena of transportation policy, planning, and funding at all levels of government.

In addition to the research, this effort will produce community outreach materials, a primer for elected officials, and a final report documenting the research.

For further information, contact Stephan A. Parker, TRB, at 202-334-2554 or SParker@nas.edu.

DYNAMIC OPTIMIZATION ON AMERICANS WITH DISABILITIES ACT PARATRANSIT SERVICE

Texas A&M Transportation Institute has been awarded a \$45,000, 18-month contract (TCRP Project J-07/Topic SB-36) to create a synthesis report documenting the current use of dynamic optimization in Americans with Disabilities Act (ADA) paratransit and the benefits realized, if any. This synthesis will develop benchmarks and operational performance measures that define the experience in the industry from the perspective of transit agencies, dispatchers, drivers, and riders. It will document the ways in which transit agencies have addressed the shortcomings and challenges evident in the tailoring, deployment, and use of dynamic optimization systems, including issues with technology and service delivery.

For further information, contact Mariela Garcia-Colberg, TRB, at 202-334-2361 or MGC Colberg@nas.edu.

MENTAL HEALTH, WELLNESS, AND RESILIENCE FOR TRANSIT SYSTEM WORKERS

Transit system workers have traditionally been subject to chronic and acute stressors that can contribute to mental health issues, including depression, anxiety, burnout, and post-traumatic stress disorders. These issues can lead to increased risk of injuries and chronic diseases, workplace dysfunction, safety issues, presenteeism (on the job but not functioning fully), absenteeism, turnover, and cost impacts.



Photo: José Miguel Guardeño, Pixabay

New NCHRP research will address measures for temporarily deterring or excluding bats from transportation infrastructures, such as bridges and culverts, where they often roost.

The ongoing COVID-19 pandemic adds another layer of stressors on essential transit system workers.

Rutgers University received a \$300,000, 24-month contract (TCRP Project F-29) to develop a comprehensive guide and interactive products to assist transit agencies and other stakeholders in exploring or implementing approaches to identify and mitigate factors that cause negative impacts on transit system worker mental health, wellness, and resilience.

For further information, contact Mariela Garcia-Colberg, TRB, at 202-334-2361 or MGC Colberg@nas.edu.



A TCRP project will examine transit system workers' chronic stressors and outcomes in pre-pandemic times and explore the acute stressors of trying to survive in highly exposed occupations amid a pandemic.

Photo: Oliver Cole, Unsplash

MEMBERS ON THE MOVE

Carlotta M. Arthur, formerly with the Henry Luce Foundation, where she served as director of the Clare Boothe Luce Program for Women in STEM, became executive director of the National Academies' Division of Behavioral and Social Sciences and Education in February.

Clay Bright, former secretary of Transportation for Tennessee, has been appointed as chief executive officer of the Megasite Authority of West Tennessee.

Lindsey Douglas, previously deputy secretary of Economic Investment, Policy, and Fiscal Affairs for the Kansas Department of Transportation, became senior director of Public Affairs—Illinois and Wisconsin for Union Pacific in January.

Nuria Fernandez, administrator of the Federal Transit Administration and an ex officio member of the TRB Executive Committee, was elected as a member of the National Academy of Engineering.

Youssef Hashash, professor at the University of Illinois at Urbana-Champaign with many years of involvement in the Standing Committee on Seismic Design and

Performance of Bridges, has been elected as a member of the National Academy of Engineering.

Stephen Maher, former TRB senior program officer, has been promoted to deputy division director/director of Program Content in the Technical Activities Division.

Karuna Pujara, former deputy director for the Maryland Department of Transportation State Highway Administration Office of Highway Development, is now vice president of Water Resource Discipline at ATCS, a professional engineering consulting firm in Herndon, Virginia.

Brian Roberts joined the Technical Activities Division (TAD) as a senior program officer in January. He has been an independent consultant and executive director of the National Association of County Engineers. He will support standing committees within the Design and Pavement sections in the TAD Transportation Infrastructure Group.

Theresia (Sia) Schatz, ACRP senior program officer, is retiring on April 22, 2022, after more than 13 years.

Susan Sillick, research manager at the Montana Department of Transportation, retired December 31, 2021. She is a member of the Standing Committee on Research Innovation Implementation Management and the Research Advisory Committee, as well as chair of the Research Coordinators Council.

Dan Sperling was elected as a member of the National Academy of Engineering. He is director of the Institute of Transportation Studies and professor at the University of California, Davis; TRB Executive Committee chair emeritus; and Standing Committee on Alternative Fuels and Technologies member emeritus.

Timothy Taylor is now director of research at the National Center for Construction Education and Research. He previously was the Terrell-McDowell Endowed Chair of Construction Engineering and Project Management in the Department of Civil Engineering at the University of Kentucky and the program manager for the Construction Engineering and Project Management Program for the Kentucky Transportation Center.

Over and Under Improving Safety and Habitat

When a stretch of I-90 in the Cascades needed rehabilitation, a Washington State Department of Transportation (DOT) project that “really started out as a way to reduce road closures due to avalanches [led to] a whole other aspect that we needed to address—wildlife connectivity,” explains Brian White, Washington State DOT assistant region administrator. The resulting public-private partnership is transforming an area where manmade barriers separated what was once one large wildlife habitat. The 15-mile I-90 Snoqualmie Pass East Project “was an opportunity to fix things for transportation and for wildlife connectivity,” notes U.S. Forest Service wildlife biologist Patty Garvey-Darda.

In the first completed project phases, multiple undercrossings enabled I-90 to rise above the land to give terrestrial wildlife—as well as aquatic species—access beneath the roadway. Careful planning added native plants to these habitat areas, many of which were planted by volunteers. A new structure at Gold Creek “allows Lake Keechelus to back up underneath the bridge and connect with wetlands that were cut off by the roadway,” White points out. Fencing that protects the roadway funnels wildlife to the Keechelus Lake Overcrossing, a massive landscaped structure that spans six lanes of I-90. The crossing is enclosed within 8-foot sound walls and closed to human passage, which encourages animals to use it.



Photo: National Park Service

From terrestrial mammals—such as the mule deer—to the aquatic coastal giant salamander, thousands of successful crossings are being recorded in Washington State’s Snoqualmie Pass area. Old culverts have been replaced to encourage wildlife to travel safely under I-90 or to use the completed, 150-feet-wide wildlife overcrossing near Lake Keechelus.

With these road improvements, wildlife is thriving and crashes caused by animals on the roadway are rare.

Learn more at www.youtube.com/watch?v=Cf5nMLrlgW4 or www.conservationnw.org/update-on-I-90-wildlife-crossings.

An App for Seniors

The city-dwelling senior citizen who once walked all over town with confidence often experiences physical or cognitive challenges that signal it is time to try transit, hail a taxi, or seek other—unfamiliar—options. To ease this transition, Connected Cities for Smart Mobility towards Accessible and Resilient Transportation (C2SMART) researchers at The University of Texas at El Paso and New York University are developing Urban Connector, a smartphone application designed to address the urban mobility needs of seniors.

A prototype of the app was developed using the results of surveys conducted with a diverse group of seniors in El Paso and New York City. Most surveyed were over age 65 and could use a smartphone for calls, text, and photos. The respondents’ listed their biggest commuting challenges as traffic congestion and parking, walking issues, and getting lost. Their trip planning concerns were transit on-time departure, protection from extreme weather, and cost.

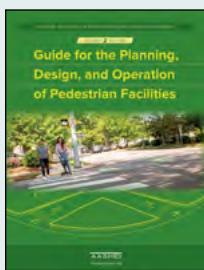
Urban Connector users will be able to specify whether they have difficulty seeing or hearing, or whether they use a cane, walker, or wheelchair. The app helps users navigate by providing transportation choices. If driving, a map with directions appears. If taking transit, route information is provided with arrival time. The researchers hope this technology will keep seniors active and counter the isolation that can accompany aging.



Photo: Alex Motoc, Unsplash

After a lifetime of enjoying the independence of walking or driving wherever (and whenever), the idea of waiting for transportation to arrive, the anxiety that it may not come on time, a lack of familiarity with public transit, the need to use a cane or other aid, and so many other factors frustrate seniors. Some simply go out less. Providing arrival, routing, and mapping information can ease that transition to less independent mobility.

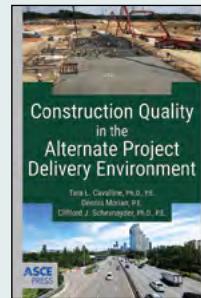
For more information, go to <https://c2smart.engineering.nyu.edu/development-of-a-mobile-navigation-smartphone-application-for-seniors-in-urban-areas/>.



Guide for the Planning, Design, and Operation of Pedestrian Facilities, 2nd Edition

AASHTO, 2021, 232 pp., AASHTO members, \$156; nonmembers, \$212. 978-1-560-51608-8.

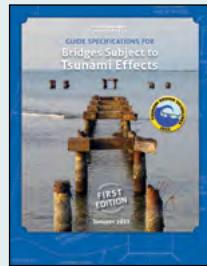
Designed for use by planners, roadway designers, and transportation engineers, this new edition is completely revised. The guide describes appropriate methods for accommodating pedestrians, which vary among roadway and facility types. It also recognizes and addresses the profound effect that land use planning and site design have on pedestrian mobility.



Construction Quality in the Alternate Project Delivery Environment

Tara Cavalline, Dennis Morian, and Clifford J. Schexnayder. ASCE, 2021, 470 pp., ASCE members, \$105; nonmembers, \$140; 978-0-784-41582-5.

This book is an ideal resource for engineers, technicians, and construction managers engaged in project design and construction. It serves as a single source of recommended quality management and quality assurance practices to support the work of engineering professionals when both conventional and alternate project delivery methods are used.



Guide Specifications for Bridges Subject to Tsunami Effects, 1st Edition

AASHTO, 2022, 55 pp., AASHTO members, \$25; nonmembers, \$34; 978-1-560-51787-0.

With these guide specifications, bridge designers can quantify forces associated with a tsunami event and apply these loads to bridge structures. For states with bridges exposed to tsunami hazard, implementing these guide

specifications will result in more robust structures that are better able to survive a tsunami event. Pricing is for a single PDF download.

The titles in this section are not TRB publications. To order, contact the publisher listed.

TRB PUBLICATIONS



Transportation Research Record 2675

Issue 10

Potential crash rate benchmarks for automated vehicles, measuring pedestrian stress levels in urban environments, virus transmission risk in urban rail systems, the effect of aircraft tire inflation pressure on thin asphalt pavements, and more are examined in this volume.

2021; 1,468 pp. For more information, visit <http://journals.sagepub.com/home/trr>.

Transportation Research Record

2675

Issue 11

Authors present research on snap judgements and availability bias in travel decisions, safety risks of unmanned aerial vehicles in construction, two-lane highway crash severities, and the influences of gesture-based mobile phone use while driving. This issue also includes papers from the 2020 ITS World Congress and the TRB Graduate Research Award Program on Public-Sector Aviation Issues.

2021; 1,440 pp. For more information, visit <http://journals.sagepub.com/home/trr>.

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



Long-Term Aging of Asphalt Mixtures for Performance Testing and Prediction: Phase III Results

NCHRP Research Report 973

This report refines the aging procedure developed in *NCHRP Research Report 871: Long-Term Aging of Asphalt Mixtures for Performance Testing and Prediction*. The updates field-calibrate the original Project Aging Model (PAM), develop procedures to estimate the PAM inputs, and develop a framework by which the predicted changes in asphalt binder properties that are due to oxidative aging can be related to corresponding changes in asphalt mixture performance.

2021; 190 pp.; TRB affiliates, \$70.50; TRB nonaffiliates, \$94. Subscriber categories: design, materials, pavements.

Application of Crash Modification Factors for Access Management

NCHRP Research Report 974

This report will aid practitioners in their use of access-management-related crash modification factors (CMFs) from AASHTO's *Highway Safety Manual* and FHWA's CMF Clearinghouse. *Volume 1, Practitioner's Guide*, presents methods to help transportation planners, designers, and traffic engineers quantify the safety impacts of access management strategies and make access-related decisions on urban and suburban arterials. *Volume 2, Research Overview*, documents the research process.

2021; 390 pp.; TRB affiliates, \$86.25; TRB nonaffiliates, \$115. Subscriber categories: highways, design, general transportation.

Initiating the Systems Engineering Process for Rural Connected Vehicle Corridors

NCHRP Research Report 978

This three-volume report provides a systems engineering approach for planning the integration of connected vehicle technologies along roadways in rural corridors. The report identifies good project starting points; helps guide agencies responsible for rural corridors to assess their needs, operational

concepts, scenarios, and requirements for connected vehicle deployment; and provides information that will apply in general to most current and proposed systems.

2021; 292 pp.; TRB affiliates, \$79.50; TRB nonaffiliates, \$106. Subscriber categories: vehicles and equipment, highways, operations and traffic management.

Attracting, Retaining, and Developing the Transportation Workforce: Transportation Planners

NCHRP Research Report 980

This report presents an assessment of current and emerging forces that are shaping transportation planning practice and the transportation planning workforce.

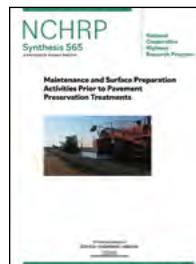
2021; 124 pp.; TRB affiliates, \$59.25; TRB nonaffiliates, \$79. Subscriber categories: administration and management, planning and forecasting.

Reliability of Crash Prediction Models: A Guide for Quantifying and Improving the Reliability of Model Results

NCHRP Research Report 983

This report complements the AASHTO *Highway Safety Manual* by providing methods for consistently ensuring model reliability.

2021; 102 pp.; TRB affiliates, \$55.50; TRB nonaffiliates, \$74. Subscriber categories: safety and human factors, operations and traffic management.



Maintenance and Surface Preparation Activities Prior to Pavement Preservation Treatments

NCHRP Synthesis 565

This synthesis documents the types of maintenance and surface preparation activities performed by departments of transportation before pavement preservation treatments, both concrete and asphalt, are applied.

2021; 104 pp.; TRB affiliates, \$55.50; TRB nonaffiliates, \$74. Subscriber categories: highways, materials, pavements.

Practices for Project-Level Analyses for Air Quality

NCHRP Synthesis 576

The requirements, modeling, and guidance for conducting project-level air quality analyses to comply with the National Environmental Policy Act and the U.S. Environmental Protection Agency's transportation conformity regulation are complex and challenging. This synthesis compiles and documents information regarding existing practices related to project-level air quality analysis by state departments of transportation.

2021; 84 pp.; TRB affiliates, \$53.25; TRB nonaffiliates, \$71. Subscriber categories: environment, planning and forecasting, general transportation.



Airport Biometrics: A Primer

ACRP Research Report 233

This report is designed to help aviation stakeholders, especially airport operators, understand the range of issues and choices available when considering—and deciding on—a scalable and effective set of solutions using biometrics. These solutions may serve as a platform to accommodate growth, as well as to address the near-term focus regarding safe operations during the COVID-19 pandemic.

2021; 248 pp.; TRB affiliates, \$77.25; TRB nonaffiliates, \$103. Subscriber categories: aviation, data and information technology, terminals and facilities.

Guidebook for Conducting Airport User Surveys and Other Customer Research

ACRP Research Report 235

This report provides airport managers and staff involved in customer research, as well as airport consultants and other stakeholders, with guidance on the effective use of airport user surveys and other customer research techniques.

2021; 242 pp.; TRB affiliates, \$74.25; TRB nonaffiliates, \$99. Subscriber categories: aviation, passenger transportation, planning and forecasting.



Legal Considerations for Telecommunications at Airports
ACRP Legal Research Digest 43

This digest examines federal requirements for various aspects of telecommunications at airports, including current issues and those implicated by emerging trends.

2021; 36 pp.; TRB affiliates, \$31.50; TRB nonaffiliates, \$42. Subscriber categories: aviation, data, information technology.



Resource Guide for Improving Diversity and Inclusion Programs for the Public Transportation Industry
TCRP Research Report 228

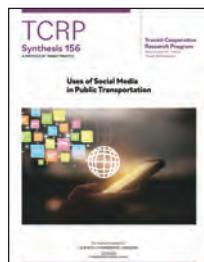
This report builds on the snapshot of transit agency diversity initiatives provided nearly 20 years ago in *TCRP Synthesis 46: Diversity Training Initiatives* to understand how diversity programs at transit agencies have evolved; how inclusion has been incorporated; and what policies, plans, and practices have been successfully implemented within the industry.

2021; 150 pp.; TRB affiliates, \$66; TRB nonaffiliates, \$88. Subscriber categories: public transportation, administration and management, policy.

Assessing and Mitigating Electrical Fires on Transit Vehicles
TCRP Research Report 229

This report provides transit systems with information and techniques to avoid the interruption of revenue service, passenger injuries, and expenditures of operating and capital funds that occur as the result of fires on transit buses and rail vehicles.

2021; 58 pp.; TRB affiliates, \$48; TRB nonaffiliates, \$64. Subscriber categories: public transportation, safety and human factors, vehicles and equipment.



Uses of Social Media in Public Transportation
TCRP Synthesis 156

This synthesis updates TCRP Synthesis 99, published in 2012, and documents innovative and effective practices of social media use in U.S. and Canadian transit agencies.

2022; 116 pp.; TRB affiliates, \$59.25; TRB nonaffiliates, \$79. Subscriber category: public transportation.

Transit Safety Risk Assessment Methodologies

TCRP Synthesis 157

This synthesis helps the transit industry better understand current and new innovative state-of-the-practice methodologies in safety risk assessment, which is an important part of the safety management system.

2022; 82 pp.; TRB affiliates, \$53.25; TRB nonaffiliates, \$71. Subscriber categories: public transportation, safety and human factors, security and emergencies.

Cybersecurity in Transit Systems

TCRP Synthesis 158

This synthesis identifies and documents emerging cybersecurity trends related to teleworking/remote worker offices, contactless customer services, real-time information services, transit-on-demand services, and cyber resilience affecting transit agencies now and in the near future as a consequence of the digital acceleration stimulated by the COVID-19 pandemic.

2022; 74 pp.; TRB affiliates, \$52.50; TRB nonaffiliates, \$72. Subscriber categories: public transportation, security and emergencies.

To order the TRB titles described in Bookshelf, visit the TRB online bookstore, <https://www.mytrb.org/MyTRB/Store>, or contact the Business Office at 202-334-3213.

VOLUNTEER VOICES

“ TRB has made a significant contribution to the profession and industry by undertaking and promoting advances in the practice of transportation planning, construction, and management. But to me, the greatest contribution is in the social sphere. Through my activities in TRB over many years, I have met, worked with, and socialized with literally hundreds of like-minded, skilled, and dedicated transportation professionals. I have interacted with these folks throughout my career, and the relationship formed through TRB has made these interactions possible.

—JACK KINSTLINGER

Chairman Emeritus (retired)
KCI Technologies, Sparks, Maryland



MEETINGS, WEBINARS, AND WORKSHOPS

May

- 15–17** **Road Use Charging and Finance Conference***
Denver, CO
For more information, contact Claire Randall, TRB, 202-334-1391, CRandall@nas.edu.
- 15–18** **International Conference on Roundabouts**
Monterey, CA
For more information, contact Nelson Gibson, TRB, 202-334-2953, NGibson@nas.edu.
- 17–21** **International Transport Forum Research Day Workshop and ITF 2022 Annual Summit**
Leipzig, Germany
For more information, contact Bill Anderson, TRB, 202-334-2514, WBAnderson@nas.edu.
- 31** **Sustainability and Emerging Transportation Technology Conference**
Irvine, CA
For more information, contact Gary Jenkins, TRB, 202-334-2311, GJenkins@nas.edu.

June

- 1–2** **Conference on Sustainability and Emerging Transportation Technology**
Irvine, CA
For more information, contact Gary Jenkins, TRB, 202-334-2311, GJenkins@nas.edu.
- 7–10** **International Conference on Managing Pavement Assets***
Chicago, IL
For more information, contact James Bryant, TRB, (202) 334-2087, JBryant@nas.edu.
- 13–15** **Biennial National Harbor Safety Committee Conference**
Boston, MA
For more information, contact Scott Brottemarkle, TRB, 202-334-2167, SBrottemarkle@nas.edu.
- 28–30** **International Conference on the Bearing Capacity of Roads, Railways, and Airfields***
Trondheim, Norway
For more information, contact Nelson Gibson, TRB, 202-334-2953, NGibson@nas.edu.

July

- 11–15** **International Conference on Bridge Maintenance, Safety, and**

Management*

Barcelona, Spain
For more information, contact James Bryant, TRB, 202-596-2087, JBryant@nas.edu.

- 24–26** **International Symposium on Transportation and Traffic Theory***
Beijing, China
For more information, contact Richard Cunard, TRB, 202-334-2963, RCunard@nas.edu.

August

- 16–19** **National Hydraulic Engineering Conference***
Atlanta, GA
For more information, contact Nancy Whiting, TRB, 202-334-2956, NWhiting@nas.edu.

September

- 6–9** **International Conference of International Society for Intelligent Construction***
Guimaraes, Portugal
For more information, contact Nancy Whiting, TRB, 202-334-2956, NWhiting@nas.edu.

*TRB is co-sponsor of the meeting.

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."

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IN MEMORIAM

Walter J. Addison, a past member of the TRB Advisory Committee on Continuing Urban Transportation Planning and the Transportation Programming, Planning, and Evaluation Committee, died on February 2, 2022. He was an adjunct professor at Johns Hopkins University in Baltimore, Maryland, and the first administrator of the Baltimore Metropolitan Transit Authority (MTA, known today as the Maryland Transit Administration).

Matthew W. Witczak, emeritus member of the TRB Design and Rehabilitation of Asphalt Pavements Committee, recipient of the 1980 K.B. Woods Award and the 1967 Fred Burggraf Award, and professor emeritus at Arizona State University and the University of Maryland, passed away in January. In 2008, he delivered the Thomas B. Deen Lecture at TRB's Annual Meeting.

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. All authors are asked to review our policy to prevent discrimination, harassment, and bullying behavior, available at <https://www.nationalacademies.org/about/institutional-policies-and-procedures/policy-of-harassment>.

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.

SUBMISSION REQUIREMENTS:

- **Articles** submitted for possible publication in *TR News* and any correspondence on editorial matters should be sent to the *TR News* Editor, Cassandra Franklin-Barbajosa, cfranklin-barbajosa@nas.edu, 202-334-2278.
- Submit **graphic** elements—photos, illustrations, tables, and figures—to complement the text. Photos must be submitted as JPEG or TIFF files and must be at least 3 in. by 5 in. and 2 megabytes with a resolution of 300 dpi. Large photos (8 in. by 11 in. with a minimum of 4 megabytes at 300 dpi)

RESEARCH PAYS OFF highlights research projects, studies, demonstrations, and improved methods or processes that provide innovative, cost-effective solutions to important transportation-related problems in all modes. Research Pays Off articles should describe cases in which the application of project findings has resulted in benefits to transportation agencies or to the public, or in which substantial benefits are expected. Articles (approximately 750 to 1,000 words) should delineate the problem, research, and benefits, and be accompanied by the logo of the agency or organization submitting the article, as well as one or two photos or graphics. Research Pays Off topics must be approved by the RPO Task Force; to submit a topic for consideration, contact Nancy Whiting at 202-334-2956 or nwhiting@nas.edu.

OTHER CONTENT

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

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

are welcome for possible use as magazine cover images. A detailed caption must be supplied for each graphic element.

Note: Authors are responsible for the authenticity of their articles and for obtaining written permissions from publishers or persons who own the copyright to any previously published or copyrighted material used in the articles, as well as any copyrighted images submitted as graphics.

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