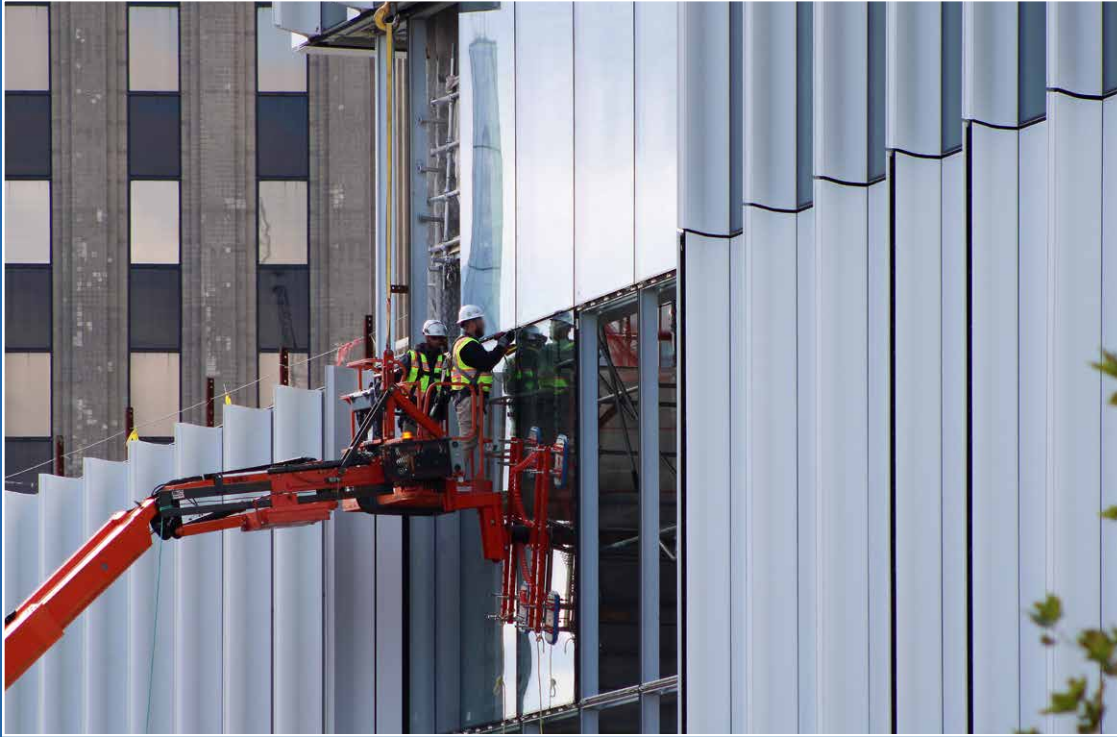




Annual Accomplishments

January 2022
Advancing Transportation Innovation for the Public Good



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LETTER FROM THE DIRECTOR



January 2022

Dear Colleagues,

Happy New Year! I am pleased to present the U.S. Department of Transportation (U.S. DOT) Volpe Center's Annual Accomplishments publication—stories about some of our most impactful and innovative work of the past year:

It's been a year of transition, one in which we began work for a new Administration, welcomed a new Secretary, and worked to advance the Department's strategic goals. Working with our sponsors at U.S. DOT and other federal agencies, the Volpe team established over 130 new agreements with multiple agencies and initiated work on nearly 200 new projects.

Our multimodal, multidisciplinary workforce continued to do what it does best—delivering high-caliber technical work that advances transportation innovation for the public good. They are to be commended for their commitment to public service and for continuing to maintain an extraordinary level of effectiveness while working remotely during the pandemic. We also welcomed 80 new employees, including over two dozen interns, continuing our commitment to strategic recruitment and hiring.

A highlight of our year was Secretary Pete Buttigieg and Dr. Robert C. Hampshire, Deputy Assistant Secretary for Research and Technology and Chief Science Officer at U.S. DOT, kicking off our 2021 thought leadership speaker series on Innovation for a Sustainable, Equitable Transportation System. The series explored how the transportation enterprise can work together to address the profound climate crisis while ensuring that decision-making and investments also address transportation equity.

Clearly, the recent passage of the Bipartisan Infrastructure Law represents a once-in-a-generation investment in the nation's transportation system. The Volpe Center looks forward to supporting implementation of this landmark legislation in the years ahead and supporting its mandate to modernize infrastructure, increase equity in transportation, help fight climate change, strengthen the supply chain, and bolster U.S. competitiveness.

The Volpe Center stands motivated, energized, and ready to help realize the promise of a transformed national transportation system.

Wishing you a safe, happy, and healthy 2022!

Anne D. Aylward

Director

Volpe National Transportation Systems Center

U.S. Department of Transportation

Previous page: Work is underway at the new U.S. DOT Volpe Center facility in Kendall Square. The steel infrastructure was completed in April 2021 and the plan is for staff to begin moving in during summer and fall of 2023. Source: U.S. DOT Volpe Center



Source: FHWA



U.S. DOT is working to make our transportation system safer for all people. The Volpe Center supports the Department's mission to ensure our nation has the safest transportation system in the world. Our multimodal safety expertise enables us to leverage proven practices from one mode to improve safety in others.

HIGHWAY SAFETY

Supporting Complete Streets Implementation across the Country

An estimated 38,680 people died in motor vehicle crashes in 2020, of which an estimated 6,205 were people walking.¹ Despite fewer miles driven in 2020 due to the COVID-19 pandemic, the fatality rate spiked among drivers; pedestrian and bicyclist deaths remained at historically high levels. In the first six months of 2021, an estimated 20,160 people died in motor vehicle crashes, up 18.4 percent over 2020. This is the largest number of projected fatalities in that time

period since 2006. This is a persistent, difficult, and preventable problem.

Of particular concern over the past decade, is the proportion of total fatal traffic crashes involving vulnerable road users (e.g., people traveling without the protection of a vehicle, such as motorcyclists, pedestrians, and bicyclists), which has increased and reached a high of 34 percent in 2019. To address these trends, the U.S. Department of Transportation (DOT) is working to help transportation agencies implement "complete streets" policies, in which roads and streets are planned, designed, constructed, and operated to enable safe access for all users.

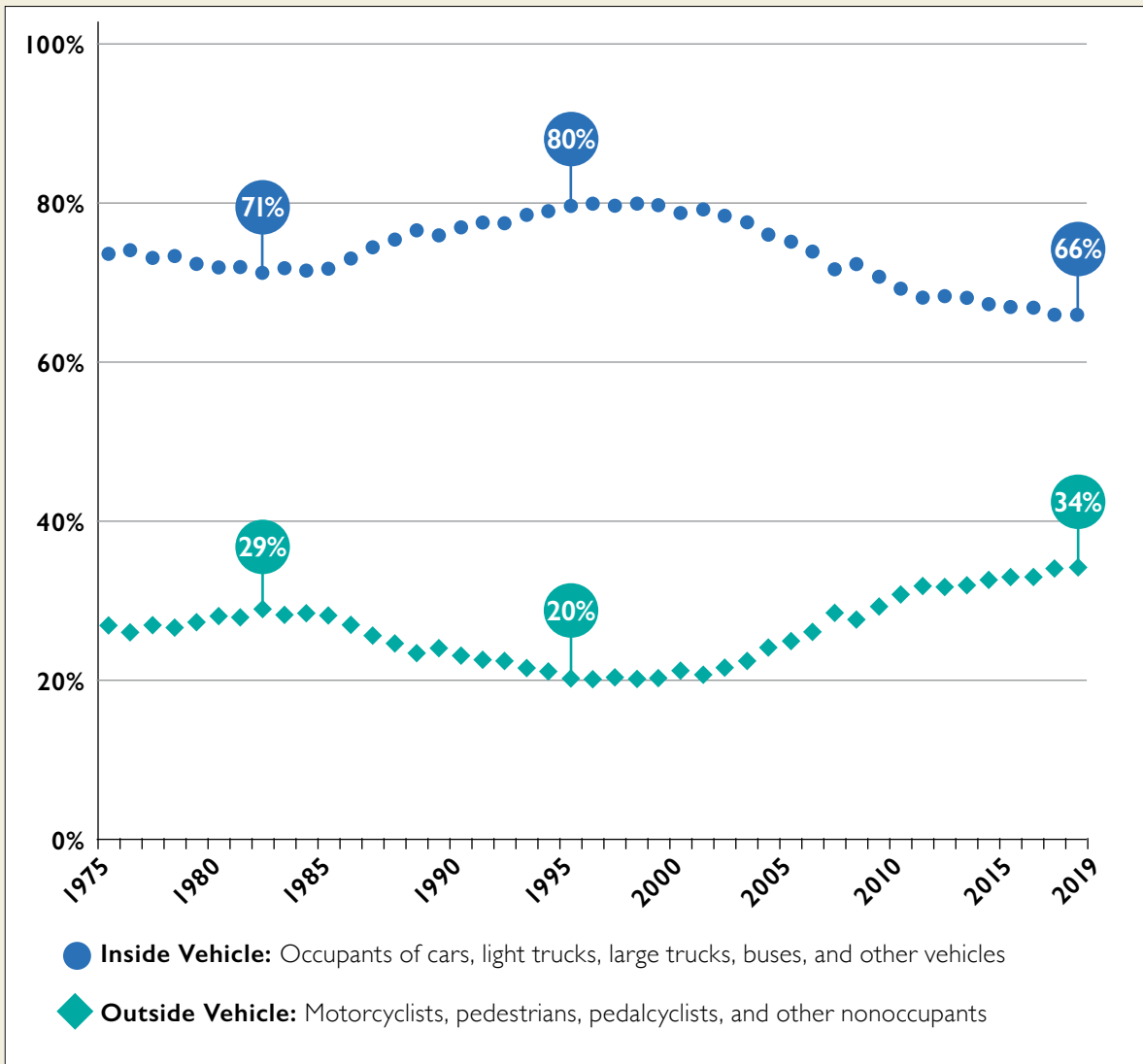
In response to an increases in fatalities and serious injuries on the nation's roadways, the Federal Highway Administration (FHWA) is encouraging state DOTs and metropolitan planning organizations (MPOs) to adopt a Safe System approach and use complete streets implementation strategies to enable safe access for all users, including pedestrians, bicyclists, motorists, and transit riders. The Volpe Center is supporting FHWA in laying the groundwork for this focus on safety.

Congress is encouraging development of a complete streets design model and directed the U.S. DOT to write a report that reviews current policies, rules, and procedures in order to determine their impact on safety for all users, with particular attention to pedestrians and bicyclists. The goal is to identify recommendations U.S. DOT can implement to support the adoption and implementation of complete streets at state, regional, and local levels.

¹ National Highway Traffic Safety Administration. "[Early Estimate of Motor Vehicle Traffic Fatalities in 2020.](#)" May 2021.

Proportion of Fatalities by Road User

1975 – 2019



Source: NHTSA

The Volpe Center is supporting FHWA's Complete Streets Steering Committee and Working Group with this initiative by reviewing federal legislation, regulations, rules, policies, guidance, and information to identify opportunities to advance safety for all users. They also coordinated interviews with state, regional, and local stakeholders and professional organizations, had conversations with U.S. DOT staff from relevant program areas, and participated in regular Working Group meetings.

The Volpe team shared initial findings with FHWA senior leadership in a memorandum and briefing in August 2021, and drafted a report to Congress which is scheduled for release in early 2022. This project will help FHWA address long-standing challenges and will benefit the safety of all road users, including but not limited to pedestrians, bicyclists, motorists, freight, and transit riders of all ages and abilities. **Sponsor: FHWA Office of Safety**

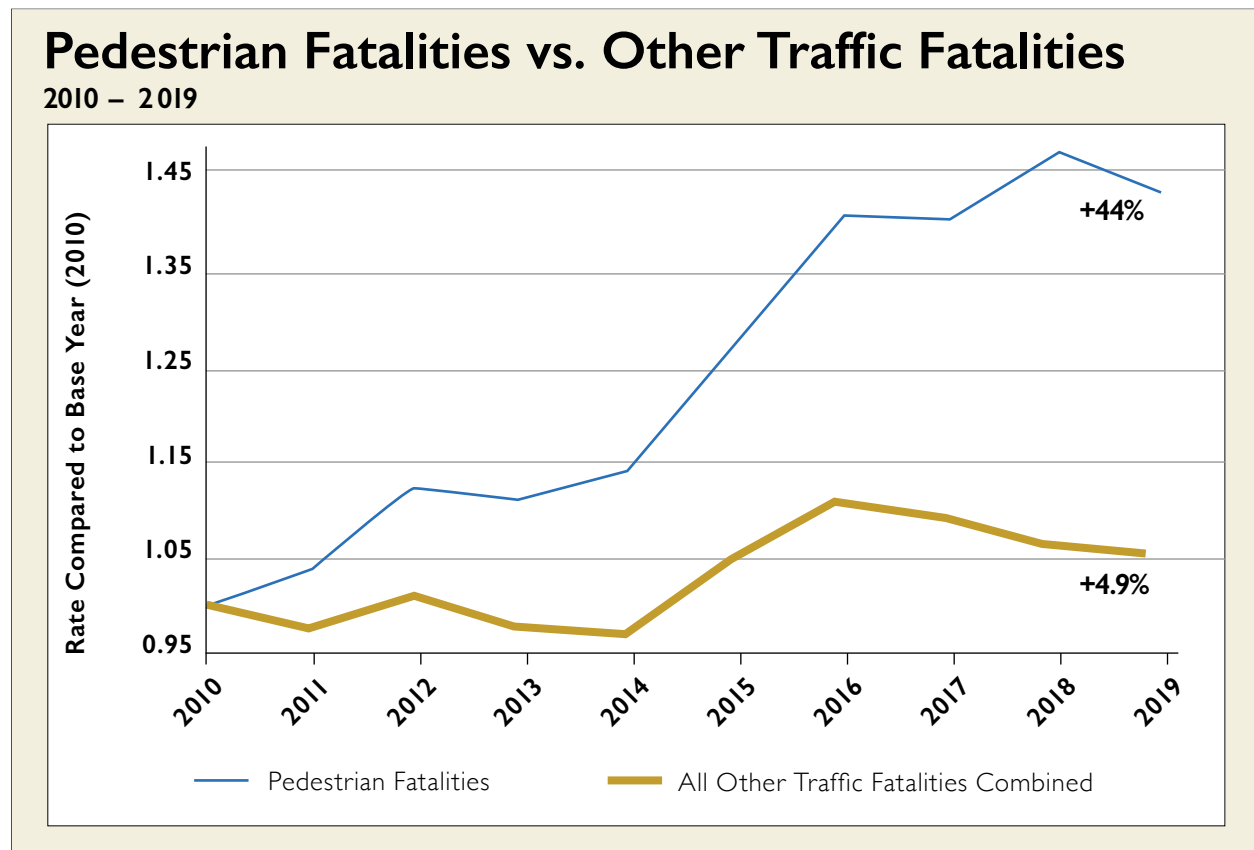
FHWA and Volpe Leading International Research on Pedestrian Safety on Urban Arterials

Pedestrian fatalities in crashes increased 44 percent in the last decade (2010 to 2019); notably, the majority of those fatalities occurred on arterial roads. Finding viable and effective solutions to protect vulnerable road users is a critical mission of FHWA. Based on the Volpe Center's experience and ongoing research in this area, FHWA asked Volpe to work with a team of experts from FHWA, state and local DOTs, and other stakeholder organizations to study the approach of countries with pedestrian safety strategies and outcomes that have reduced serious injuries and fatalities.

The study is being carried out under the FHWA's Global Benchmarking Program (GBP), which connects

U.S. subject matter experts (SMEs) with transportation professionals around the world and serves as a tool to access, evaluate, and implement proven innovations that have the potential to improve highway transportation in the U.S. The Volpe Center provides support to FHWA in administering the GBP. This work includes coordinating team member meetings, managing stakeholder engagement, facilitating the selection of country destinations, coordinating international travel, and providing implementation support.

In the first phase of the study project, the Volpe Center completed an extensive literature review to gain insights into the policies, funding programs, planning practices, engineering solutions, data evaluation, and operational strategies underpinning successful pedestrian safety programs in Australia, Canada, Colombia, Denmark, the Netherlands, New Zealand, Norway, and Sweden. In addition, the Volpe Center conducted interviews with more than 45 individuals representing national, regional, and municipal



Rate of U.S. pedestrian fatalities vs. all other traffic fatalities combined, 2010–2019. Source: NHTSA Crash Statistics

government agencies; planning and engineering contractors from private industry; academic and research institutions; and non-profit transportation organizations. Based on the research findings, the GBP study team selected Australia and New Zealand as the best peer countries for additional study during the second phase of this project, due to their successful implementation of the Safe System approach to Vulnerable Road User safety.

The Volpe Center also conducted four virtual exchanges with experts from both countries in October and November 2021. Pending travel allowance, Volpe will coordinate and plan the logistics for the study team's visit to Australia and New Zealand in spring or summer 2022. A Volpe team is leading the research, SME coordination, and documentation that will be included in a final report and recommendations for FHWA. In addition to the final report, the Volpe Center will help develop an implementation plan and provide support to FHWA in applying best practices and lessons learned from the exchange in the U.S.

Sponsors: FHWA Office of International Programs / Global Benchmarking Program. **Technical Leads:** FHWA Office of Safety, and Office of Human Environment

Increasing Access to Work Zone Information to Improve Highway Safety for All

The nation's transportation system is increasingly data driven. Safe and efficient mobility for all is dependent on reliable real-time information about work zones and other disruptions to usual traffic patterns. Standardizing access to these data is critical to improving safety—not only for keeping highway workers and drivers safe, but also for efficiently integrating automated vehicles (AVs) into the transportation network. Most infrastructure owners and operators (IOOs) maintain data on work zones, but the lack of common, simple standards makes it cumbersome and costly for third parties to access and use these data effectively.

The Intelligent Transportation Systems Joint Program Office (ITS JPO) launched the Work Zone Data Exchange (WZDx) project in 2018 to jumpstart adoption of a simple, open data specification that allows IOOs to provide consistent work zone activity data to third party users. The ITS JPO collaborated with the Volpe Center's innovation experts on the WZDx project based on Volpe's long-standing commitment to providing high-quality strategic development, scope assessments, and exploratory research.

The Volpe Center co-leads the WZDx project with FHWA and the ITS JPO. Since launching the project, the Volpe Center team has convened key stakeholders to guide iterative development of the WZDx specification. Through consistent outreach and promotion, the Volpe Center team has helped grow the stakeholder community from 10 to over 250 members representing 100 agencies and organizations including state and local DOTs, automated vehicle developers, navigation applications, and construction companies. The Volpe Center has championed this community—now a leading voice for work zone data and information—by providing leadership and a strategic vision for nationwide work zone data sharing, as well as undertaking research into crucial issues such as how to share consistent but flexible data about the presence of workers in work zones.

WZDx is also serving as a platform for communicating other information crucial to highway safety. The specification has been extended to include a way for IOOs to specify detour routes that drivers should follow around a road closure. WZDx stakeholders are expanding the specification to include other geospatial data, such as bridge/overpass clearances, traffic incidents, and more.

To date, five state DOTs have initiated WZDx data feeds and an additional ten IOOs will deploy new feeds by early 2022 with funding assistance from the ITS JPO. The Volpe Center is building momentum to provide the national standard for work zone data and works with data producers, aggregators, and publishers to understand and eliminate barriers to providing these data to those who need them. **Sponsor: ITS-JPO**

Cybersecurity and Privacy Risk Development for Connected Vehicle Environments

As transportation technology continues to evolve and more connected vehicles are deployed on the nation's roadways, cybersecurity and privacy risks will increase. To manage and mitigate risks associated with connected vehicle environments, the Volpe Center, in support of the Intelligent Transportation System Joint Program Office (ITS JPO), led the development of the Cybersecurity Framework for Connected Vehicle Environments (CSF for CVE) and the Privacy Risk Assessment Methodology for Connected Vehicle Environments (PRAM for CVE).

The Volpe Center developed these tools in collaboration with the National Institute of Standards and Technology's (NIST) National Cybersecurity Center of Excellence (NCCoE). The purpose of these tools is to help state and local DOTs manage the cybersecurity and privacy risks associated with development and deployment of connected vehicle technologies. The tools were published on [ITS JPO's Cybersecurity Research webpage](#).

Volpe is currently working on its second CSF profile effort, sponsored by ITS JPO and FHWA, again in collaboration with NIST's NCCOE, to broaden the profile to include ITS more generally and develop an instructive reference implementation for demonstration purposes. Beginning in September 2021, the Volpe team hosted a series of workshops to gather input from Traffic Management Center SMEs. A series of workshops with transit agency SMEs was also planned for fall 2021, and the input from participants will be used to better tailor the profile to ITS practitioners' needs and objectives.

These efforts will provide state and local DOTs and transit agencies across the nation with tools to address the increased risk of cyber and privacy events brought on by the growth of connected vehicle technologies.

Sponsor: ITS JPO

Positioning, Navigation, and Timing Technology Readiness for Safe Automated Vehicle Operations

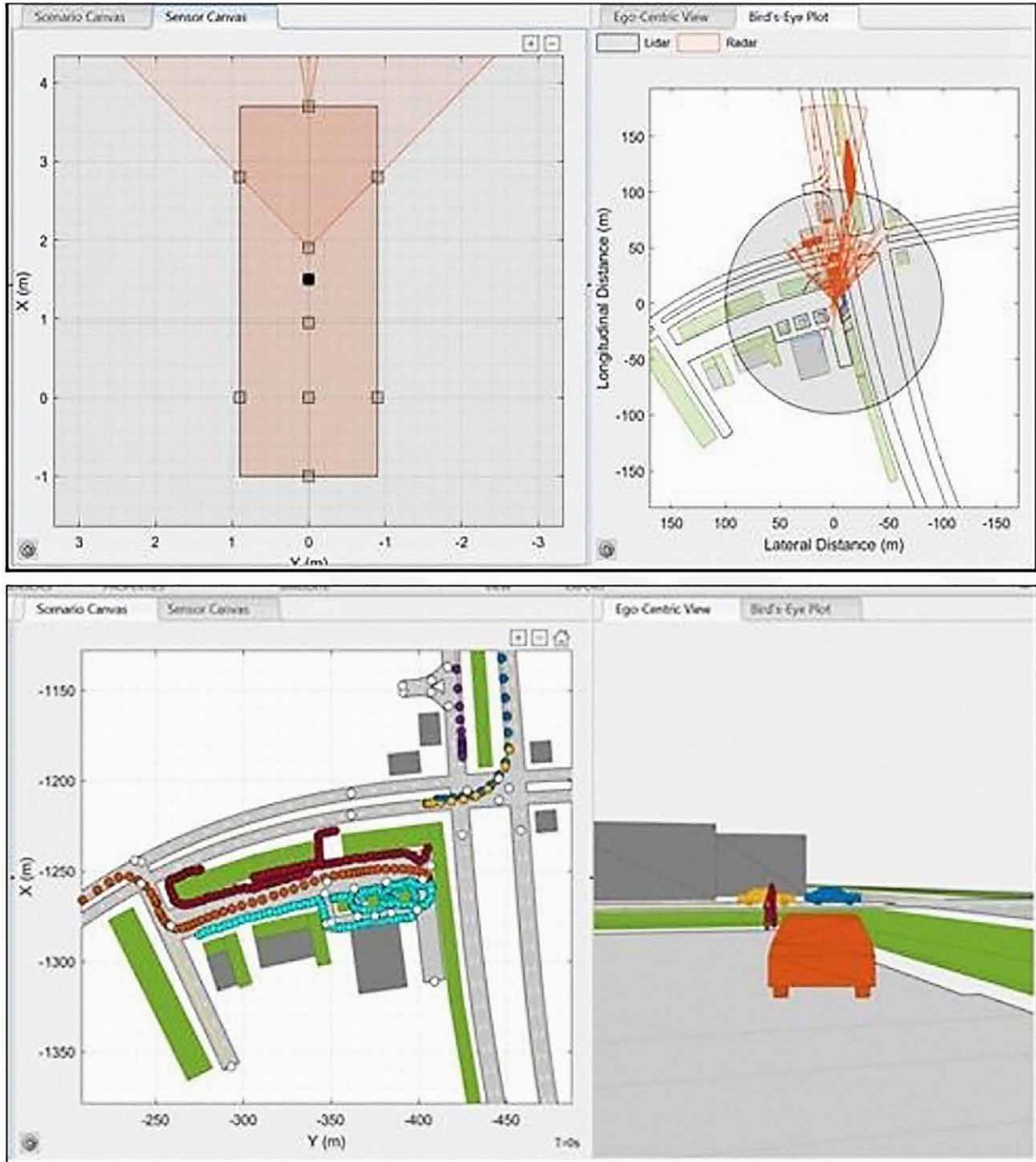
Traffic accidents in the U.S. continue to result in a large number of fatalities—over 36,000 per year for 2018 and 2019.² More than 90 percent of these accidents are attributable to driver error. Highly automated surface transportation that reduces or eliminates driver involvement carries many potential safety benefits that are not yet fully realized. Automated vehicles and automated driving systems (ADS) could significantly reduce fatal crashes and save lives on the nation's roadways.

However, the ability of ADS to perform safer than human drivers must first be demonstrated for varying operating and environmental conditions. These systems must also demonstrate resilience to intentional cybersecurity and spoofing attacks. Determining the Positioning, Navigation, and Timing (PNT) requirements for those systems and evaluating sensor performance against these requirements via data collection and analysis will help increase the safety of AV operations and reduce incidences of AV-related traffic accidents.

The ITS JPO turned to the Volpe Center to lead the development and implementation of an AV PNT technology assessment framework. The Volpe Center's expertise with Global Satellite Navigation Systems (GNSS) and other PNT technologies; signal and image processing; data analysis; remote sensor analysis and simulations; and the development and verification of requirements for multimodal applications, fully equipped the team to tackle this challenge.

The main objectives for Volpe's work are to determine PNT requirements, assess candidate PNT technology solutions for AV operations under defined scenarios,

² Fatality Analysis Reporting System (FARS); <https://www-fars.nhtsa.dot.gov/Main/index.aspx>.



and assess the state of readiness of available and emerging PNT solutions. This work is intended to support the U.S. DOT's vision outlined in Automated Vehicle 3.0, which identifies PNT as one of the technology areas that can benefit from voluntary technical standards. It also supports the U.S. DOT's

Top left figure illustrates the approach of sensor placement and corresponding field of view with respect to the vehicle frame. Top right figure shows radar returns from a single scan. Bottom figures show the various tracks or scenarios as different color traces and on-road actors including pedestrians, other vehicles, structures, and vegetation.

Source: U.S. DOT Volpe Center

AV 4.0 vision, which prioritizes safety and emphasizes security and cybersecurity, by assessing sensor suite PNT performance in the presence of signal jamming and spoofing attacks on one or more sensors. This work supports Executive Order 13905 to ensure disruption or manipulation of PNT services does not undermine reliability or efficiency of critical infrastructure.

The Volpe team outlined a framework to assess AV PNT sensor performance, which included identifying requirements and developing scenarios to evaluate sensor suite performance and resiliency under various environments and conditions. The development of simulation scenarios and data processing rubrics can be applied to many driving environments including highways, suburban roads, residential areas, urban areas, and covered roads such as tunnels.

The Volpe team gave a technical presentation to ITS JPO staff, surveying state-of-the-art, highly automated vehicle operations in industry and academia. For each case, the description included the location(s) of sensor data collection and the suite of sensors used in each operation. Throughout 2021, Volpe Center staff collected and processed on-road data in Fairfax, Virginia, and in government-sponsored testing events. These locations were selected because they offered a range of operational design domain conditions, such as highway, suburban, and urban environment settings. The Volpe Center is also developing simulation scenarios for realistic driving environments. **Sponsor:**
OST-R/ITS JPO

RAIL SAFETY

Development of Artificial Intelligence Tool for Railroad Safety Applications

Over 95 percent of all rail-related fatalities in the United States result from trespassing and grade crossing collisions. In 2020, there were 1,901 grade crossing incidents, resulting in 197 fatalities and 688 injuries. That same year saw an additional 525 trespass fatalities and 557 injuries. The majority of these incidents were preventable.

The goal of the Federal Railroad Administration's (FRA) grade crossing safety and trespass prevention research is to analyze crash causation and develop safety countermeasures, programs, and guidance to reduce the number of casualties at grade crossings and along railroad rights-of-way (ROW).³ To meet this goal, FRA is working on a computer vision tool for automated detection of grade crossing violations and trespass activities from camera feeds that monitor

3 U.S. Government Grade Crossing Research & Stakeholder Engagement; https://railroads.dot.gov/sites/fra.dot.gov/files/2020-01/GX_ILCAD%206.6.19_PDFa.pdf.

Example of video processing output showing pedestrians and vehicles traversing a grade crossing at Ramsey, NJ. Source: U.S. DOT Volpe Center



ROW. The availability of timely, high-quality data is key to this effort. Currently, railroads and state DOTs have a wealth of ROW video monitoring data, but those data are generally only analyzed in the event of a documented trespassing incident or fatality.

At FRA's request, the Volpe Center is conducting research to develop an artificial intelligence (AI) computer vision tool for automated detection of violations and trespass activities in railroad-monitoring video feeds. Automated identification and processing of trespassing and grade crossing violations will yield a significant safety data set that is currently not being collected. A goal of Volpe's research is to improve video processing performance, which will enable real-time use at grade crossing locations. The ability to detect trespass events in real-time could significantly improve safety and reduce incidents at grade crossings.

The FRA Grade Crossing Trespass Detection (GCTD) project has implemented a solution that can detect trespass events using multiple computer vision neural networks trained to detect and track pedestrians and vehicles using pre-installed cameras and video feeds. This ability to accurately detect a trespassing event using standard video input will help reduce the human capital needed to collect useful safety data for rail grade crossings. To date, the FRA GCTD project has developed multiple computer vision neural networks that collectively work together to detect trespassers. Each individual neural network contributes key data to the detection pipeline and has specific quantitative metrics that represent the model's performance on input data.

The Volpe team identified publicly available video feeds that monitor railroad ROW, developed the computer vision architecture, provided training for each individual computer vision model on the required data, and developed the algorithm used to perform the final trespass event detection. Volpe expertise in deep learning computer vision was leveraged extensively to develop both the video data input pipeline and the required event classification process.

Volpe staff recently presented research findings for Phase II of this work in a peer review session involving

several academic and government groups also engaged in similar research. FRA is also working to draft a formal research paper that will outline the novel approach used to perform the trespass detection developed for this project. **Sponsor: FRA**

Delay Costs in Transportation Incidents of Hazardous Materials by Rail

Approximately 27 derailment or collision incidents involving hazardous materials occur on U.S. railroads every year. Of these accidents, 41 percent result in the closure of a major transportation artery, with a median track closure of 24 hours. A hazardous materials (HAZMAT) rail incident can shut down a segment of track and significantly impact freight railroads, rail passengers, and nearby roadway users.

The Pipeline and Hazardous Materials Safety Administration (PHMSA) partnered with FRA to study the cost of delay associated with HAZMAT-related rail accidents. PHMSA sought the expertise of the Volpe Center's economists, geographic information system (GIS) specialists, and SMEs on passenger rail and vehicle emissions for this effort. A Volpe team synthesized a variety of information from public data sources, the Surface Transportation Board (STB) confidential waybill sample data, and various transportation modeling techniques to develop a method to estimate the cost of delay for both freight and passenger rail operations as well as delay that may be experienced by the roadway user.

Volpe's multidisciplinary team worked together to model the main factors that impact the cost of delay, including freight and passenger rail volumes, track capacity, the marginal impact of the presence of HAZMAT on the duration of closure, train congestion, locomotive emission rates, train crew costs, equipment costs, passengers per train, fuel costs, and the social costs of emissions. The scale of impacts varies according to the level of freight and passenger rail traffic at any individual site. The various model components were

combined by the Volpe team to produce estimates for a variety of scenarios covering locations throughout the U.S. freight rail network.

The methods developed in this project could potentially be used for estimating costs of rail delay for a variety of purposes including the benefits of expanding rail infrastructure or preventing other types of rail incidents, not just HAZMAT rail incidents. Research findings can be used to support policy and regulatory decision-making related to HAZMAT transport by rail.

In some situations, the presence of HAZMAT in a rail incident can significantly increase the amount of time the track segment is closed. Initial results indicate that those longer closure times can result in additional delay costs of \$2.3 million per year.⁴

In May 2021, Volpe completed a report describing the initial results of the research and on June 17, 2021, the

⁴ \$2.3 million per year is a preliminary estimate.

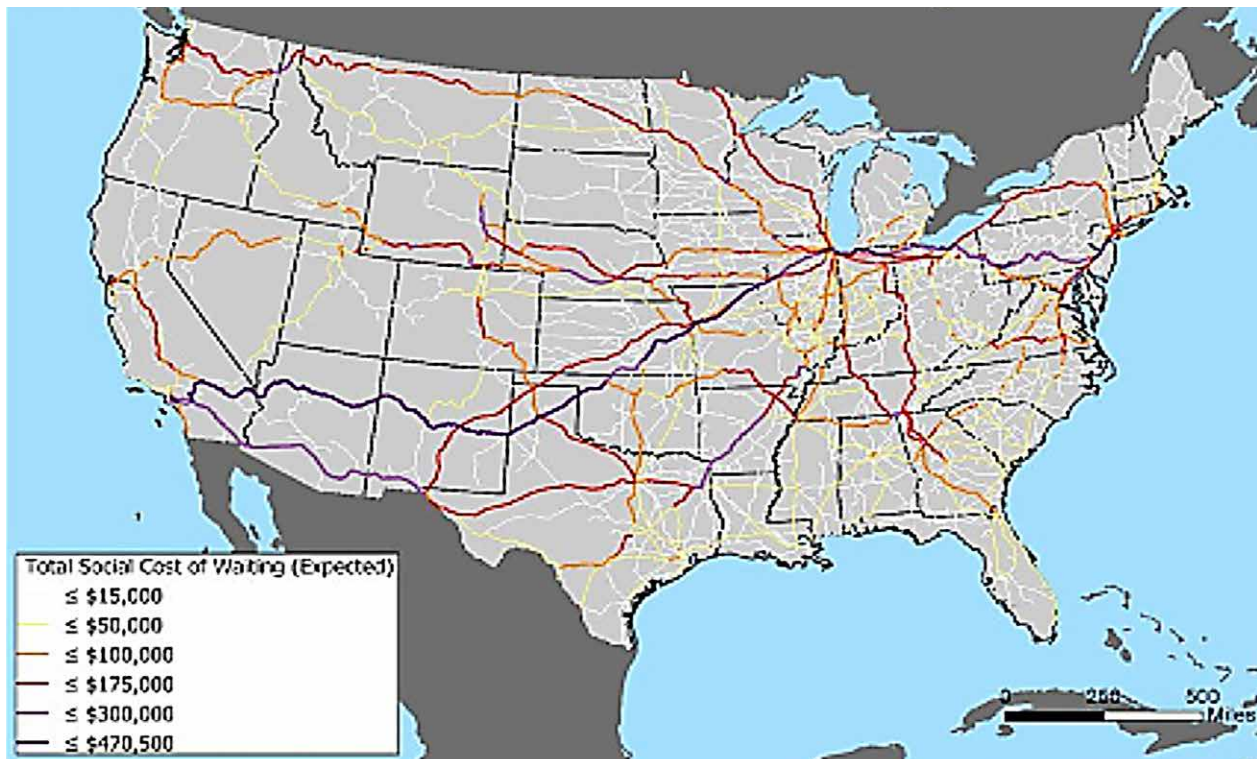
Social cost of delay due to HAZMAT-related accidents when freight railroads wait. Source: U.S. DOT Volpe Center

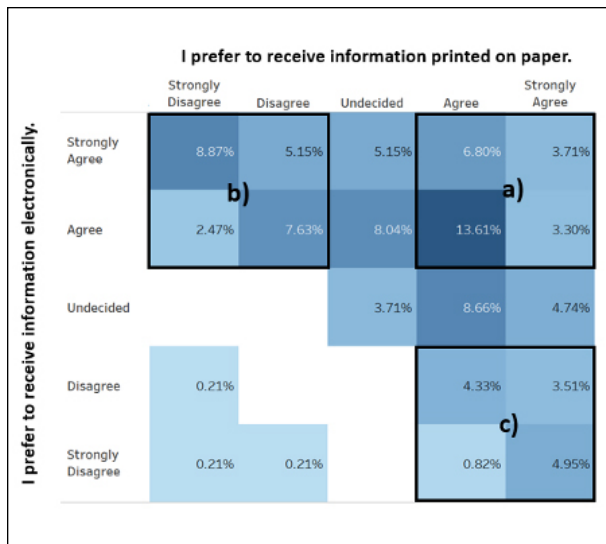
Volpe team provided a briefing on those initial results to key stakeholders, including representatives from the Association of American Railroads, American Short Line and Regional Railroad Association, and Amtrak. Future work will involve incorporating the stakeholder feedback to refine the cost of delay estimates. **Sponsor:**

PHMSA, with FRA input

Information and Communications Technology Survey of Class I Railroad Train, Yard, and Engine Workers

As the railroad industry increases its use of technology to share information and communicate about safety, organizations should understand how their target audiences utilize these methods. The FRA regularly uses Information and Communications Technology (ICT) to disseminate research findings and to increase safety awareness. ICT refers to the technology and





Highlight table showing relationship between preferences for receiving information printed on paper and electronically (n=466) Source: U.S. DOT Volpe Center

tools used to share, distribute, communicate, and gather information. While studies have examined ICT use among the general population, there has been no known research into train, yard, and engine (TY&E) railroaders' ICT use, confidence, and preferences.

To address this research gap, the Volpe Center conducted a comprehensive survey of TY&E railroaders with the objective of generating baseline data from railroad employees across three domains: (a) ICT access, use, and preferences; (b) Familiarity with and use of the FRA-sponsored ICT-based Railroaders' Guide to Healthy Sleep website; and (c) Employee demographic characteristics.

Between May and July 2020, with collaboration from the Brotherhood of Locomotive Engineers and Trainmen and the International Association of Sheet Metal, Air, Rail and Transportation Workers-Transportation Division, the Volpe Center surveyed more than 2,000 of the roughly 70,000 active TY&E employees working for U.S. Class I railroads nationwide, giving respondents the option of completing a questionnaire on paper or online. The survey had a response rate of approximately 25 percent, and over 70 percent of respondents chose a paper response rather

than online, emphasizing the importance of Volpe's survey design strategy.

Results from the survey showed that 27 percent indicated they preferred receiving both paper and electronic information. Close to one quarter (24.1 percent) of respondents preferred electronic information, and did not prefer paper, while far fewer (13.6 percent) preferred information on paper and did not favor electronic information. Based on these results, the Volpe Center recommended using paper-based communication in addition to electronic forms for optimal communication of safety information with this audience.

In February 2021, upon completion of data collection, the Volpe Center submitted a draft technical report to FRA with findings and recommendations. The survey results will help inform educational outreach across the railroad industry and improve knowledge dissemination efforts nationwide, as well as accurately tailor communications methods to railroader's preferences.

Sponsor: FRA, Office of Research, Development, & Technology

AVIATION SAFETY

Volpe Center Assesses Pilot Perceptions of Electronic Flight Bag Information Management and Training

Managing flight operations can be a challenging task for commercial airline pilots, from checking flight plans, monitoring weather and route changes, and communicating with the flight crew and air traffic control. Innovative tools have been introduced to the aviation industry in recent years that have the potential to assist pilots with routine flight deck activities. The Volpe Center recently provided the Federal Aviation Administration (FAA) with data from airline pilots on their training and use of tablets and other permanently mounted or installed devices (less commonly) to help manage Electronic Flight Bag (EFB) functions on the

flight deck, such as charts, manuals, checklists, weather, and more.

An EFB is any electronic information management device that displays secondary flight information and helps pilots perform flight management tasks by hosting applications that replace conventional paper products and tools traditionally carried in the pilot's flight bag. These devices and applications tend to undergo rapid changes in technology and capability, therefore pilots will need to adapt quickly in order to manage information on the flight deck effectively and safely. The FAA is keenly interested in understanding how pilots manage information used for EFB functions, and the impact EFBs have on flight operations and safety.

The Volpe Center conducted three separate data collection efforts across a two-year period from July 2016 to August 2018. First, a Volpe team held individual interviews with nine pilots on topics including training, managing information, workload, distraction, and head-down time. Building upon the opinions gathered during these interviews, the Volpe team conducted two group discussions with a total of nine additional airline pilots in coordination with the 2018 annual Air Line Pilots Association (ALPA) meeting. Lastly, the Volpe Center provided assistance to ALPA in conducting an online survey on the usability of EFBs, in which 1,047 pilots submitted responses.

The results showed that pilots are generally satisfied with electronic chart software and functionality. Nearly every pilot who responded to the survey said they could easily interact with their charts (e.g., adjusting the zoom level or making inputs) while the autopilot is engaged. However, 56 percent of those pilots felt that making inputs and adjusting the zoom level was substantially more difficult while manually flying the aircraft compared to using autopilot.

With respect to training, responding pilots felt overall that in-person training is preferable to online or distance learning for EFB functions and devices, so that trainees have the opportunity to actively participate using their devices and to ask questions. Pilots noted it would be more helpful for training to be developed around the operational tasks that require use of EFB

information, rather than covering all the capabilities available on their devices.

Pilots perceived their workload and head-down time to be improved in some areas and increased in others with EFB use compared to paper. Survey data showed that two-thirds of pilots felt that managing EFB information decreased workload and head-down time when compared to using paper.

This two-year research effort resulted in the publication of a final Volpe Center report released in May 2021⁵ that provides detailed findings and responses from pilots on EFB setup, training, device reliability, battery and power issues, electronic charts and documents, distractions, head-down time, and other important findings.

As capabilities evolve and the amount of information on EFB devices grows, it is important to maintain awareness of EFB capabilities and limitations on the flight deck. This project contributes to the overall understanding of flight deck information management and potential impacts on flight operations in the National Airspace System (NAS). Understanding these impacts can assist the FAA in their mission to ensure the highest level of safety for the flying public. **Sponsor:**
FAA Human Factors Division in support of the Aircraft Certification Service Systems Integration Section

DoD/FAA Identification Friend or Foe, Cooperative Surveillance, and 1030/1090 MHz Spectrum Environment Model

As the aviation industry recovers from the COVID-19 pandemic, the FAA projects commercial aviation to rebound to pre-pandemic levels and then increase

⁵ Chase, S.G. and D. Hiltunen, *Electronic Flight Bag (EFB) Information Management and Training. Final Report April 2021. DOT-VNTSC-FAA-21-08 and DOT/FAA/TC-21/26. US DOT Volpe Center, April 2021. At https://rosap.ntl.bts.gov/view/dot/56269/dot_56269_DS1.pdf.*

by 1.5 percent year-over-year.⁶ In preparation for this expected surge, FAA and other aviation stakeholders must ensure all aviation modes can safely operate while sharing the same spectrum bands in order to prevent spectrum congestion. Excessive spectrum congestion can lead to loss of data, late transmission and/or reception of data, and other hazardous effects in the NAS that can degrade pilots' and air traffic control's (ATC) ability to maintain aircraft separation.

The Department of Defense (DoD) and FAA sponsored the Volpe Center to develop an interim process and prediction model that will inform the spectrum certification and frequency assignment processes for DoD Identification Friend or Foe (IFF) systems. This would become known as the IFF Technical Working Group (TWG) Stage 1 Model. The model will be able to estimate the spectrum impact caused by adding, modifying, or removing aircraft, ground-based, and ship interrogators and receivers that use the 1030/1090 MHz spectrum band. The model will improve stakeholders' ability to monitor the 1030/1090 MHz spectrum, which is the frequency band used by Automatic Dependent Surveillance-Broadcast (ADS-B), Secondary Surveillance Radar (SSR), and other safety-critical systems in the NAS.

The Volpe Center completed the Stage 1 model in 2019 and work is now underway on the Stage 2 model, which will be hosted on the FAA Cloud Services platform to allow for greater access to NAS data and improved processing time, whereas the Stage 1 model was developed in MATLAB. The Stage 2 model will be accessed from a web page, which will increase stakeholder usage. Volpe delivered the Stage 2 Model Software Requirements Specifications document in September 2021, which describes what the software will do and how it will be expected to perform.

The Volpe team provides frequent updates to a subject matter expert/stakeholder working group on the document's progress. In the future, Volpe will provide technical expertise that supports the development and

testing of the Stage 2 Model, and work with the FAA Air Traffic Organization Cybersecurity Group to put the model into production mode. Volpe's expertise in radio frequency spectrum, air traffic control, air traffic management, ADS-B, SSR, and multilateration systems were an asset to this project.

The Stage 2 model will show the 1030/1090 MHz spectrum environment tactical and strategic evaluations. The tactical evaluation refers to real-time, or near real-time assessment of potential exceedance of the spectrum limits in the NAS. The strategic evaluation refers to prediction of spectrum impacts from a change in the NAS (e.g., military exercises, adding/modifying/removing equipment), and determining whether the change will result in exceedance of the available spectrum budget in the NAS.

With access to more accurate and timely information on the spectrum environment, authorities can make better decisions to allocate spectrum, and approve or reject requests for spectrum. As a result, the NAS can accommodate more aircraft using key spectrum bands while maintaining the same level of safety. **Sponsor: U.S. DoD Office of the Chief Information Officer (CIO) (sponsor) FAA Spectrum Engineering Office (sponsor)**

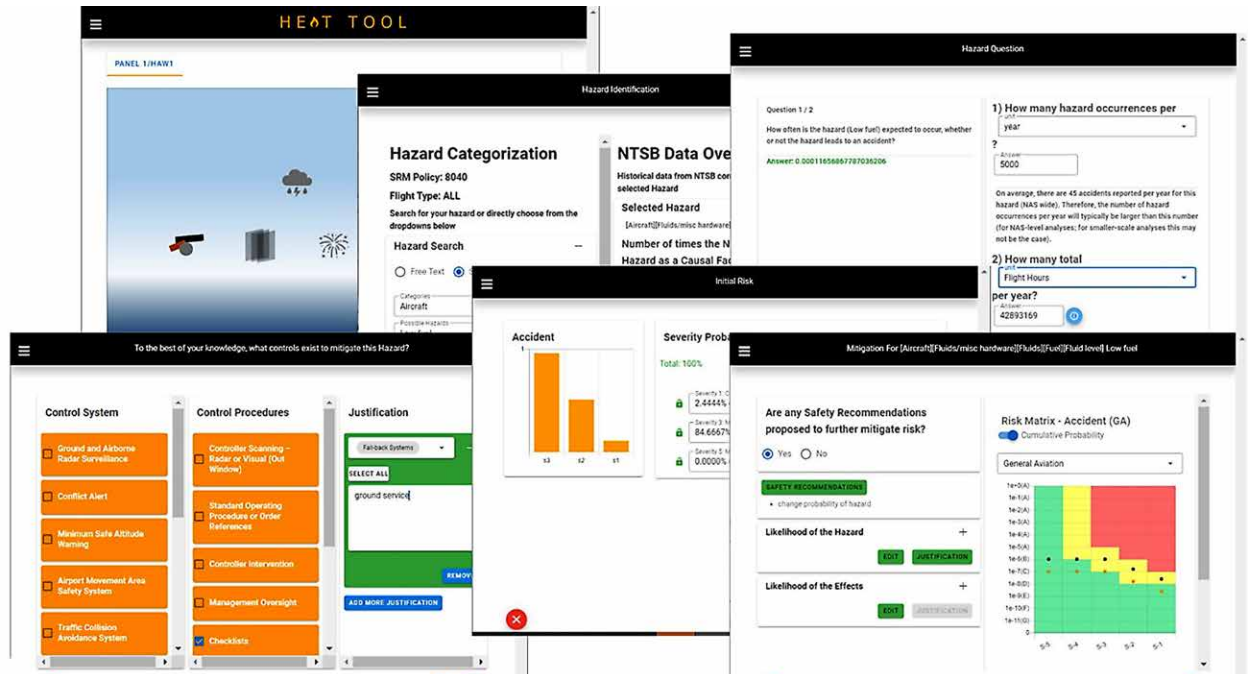
Developing the FAA Hazard Enterprise Assessment Tool Smart Device Application

Managing known and unknown risk is an important aspect of maintaining system safety, especially in the field of aerospace operations. Safety Risk Management (SRM) uses decision-making tools to provide a formalized approach to safety, and is used to evaluate the need for, and to develop, risk controls for new and existing safety issues in the NAS.⁷

With solicited support from the Volpe Center, the FAA is currently creating the Hazard Enterprise

6 The Federal Aviation Administration (FAA) Aerospace Forecast Fiscal Years (FY) 2020-2040 Press Release; https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=24756.

7 Introduction to Safety Risk Management; <https://www.faa.gov/sites/faa.gov/files/2022-01/Intro%20to%20SRM.pdf>.



A sampling display of key HEAT smart device pages. Source: U.S. DOT Volpe Center

Assessment Tool (HEAT), an innovative smart device application that provides a powerful new database-driven method to determine hazards, risk, and causes of safety-related incidents. It is also flexible enough to accommodate new and known hazard identification; provides step-by-step guidance through SRM procedures in a convenient, user-friendly, comprehensive, and portable manner; provides new guidance for entering and determining probabilities; and features automatic calculation with data reporting.

The HEAT is expected to improve the way national SRM panel activities are conducted. An SRM panel consists of FAA participants and SMEs whose main objective is to assess the risk associated with hazards existing in the NAS. Currently, risk analysis mainly depends on SME experience. The HEAT broadens and supplements this experience by applying robust databases and common guidance questions that should result in SRM panels with more objective, precise, and standardized results, encouraging and allowing equal participation for each SRM panel member, and enabling round-the-clock access to SRM data. The HEAT's impact is expected to increase the accuracy of

the overall final risk determined by the SRM panel and makes it easier to manage difficult analysis.

The HEAT will be used by SRM panel participants with their own smart device, and will virtually walk users through the usual, and newly augmented, procedures of an SRM panel, encourage communication between panel members, support multiple panels, and help facilitate the generation of a final SRM document.

Use of the HEAT should result in determining a more accurate degree of risk by providing a uniform common framework that each SRM participant must adhere to, hence ensuring participation is equal, and providing built-in comprehensive and accurate databases from which to obtain information. The HEAT is currently being tested by use in real SRM panels and the final product is to be delivered by June 2022.

The Volpe Center team provided smart device graphical user interface expertise, database capability, and mathematical/probability knowledge for this effort. In addition, the Volpe Center leveraged critical probability software and deliverables developed by Volpe experts for a previous related project. **Sponsor: FAA**



The European green crab is a highly adaptable ANS that competes with and displaces native crab species and has altered the inter-tidal areas of rocky shore ecosystems in the U.S. Source: Adobe Stock

MARINE SAFETY

Protecting U.S. Ecosystems and Human Health by Managing Ballast Water

Ballasting or de-ballasting is a process by which sea water is pumped into a ship's ballast tanks to help stabilize a vessel when it is not filled with cargo, and out of a ship when it is docked at port or out to sea. While ballast water is essential for the safe and efficient shipment of products and materials, it does present serious ecological, economic, and health effects from invasive organisms transported in the water. The spread of invasive organisms is now considered one of the greatest threats to the ecological and economic health of the planet.⁸ Ships discharging ballast water run the

8 Ballast Water Management; <https://www.imo.org/en/OurWork/Environment/Pages/BallastWaterManagement.aspx>.

risk of introducing aquatic nuisance species (ANS) and pathogens into the waters of the U.S. Invasive species pose a significant threat to U.S. ecosystems, and have the potential to cause serious harm to U.S. citizens.

In 1990, the National Aquatic Nuisance Prevention and Control Act authorized the U.S. Coast Guard (USCG) to develop and implement a regulatory program to prevent the introduction of ANS into the waters of the United States by ships discharging ballast water. Pursuant to the National Invasive Species Act of 1996 (NISA), the USCG published regulations that established the National Ballast Water Program for U.S. Waters. USCG's Final Rule, Standards for Living Organisms in Ships' Ballast Water Discharged in U.S. Waters (Federal Register Vol. 7, No. 57; March 23, 2012), requires that ships manage ballast water to comply with the discharge standard. A key component of the USCG ballast water program requires that all ships manage their ballast water if entering U.S. waters after operating outside of the U.S. Exclusive Economic Zone. Mid-ocean ballast water exchange was the primary method of managing ballast water until the Final Rule was promulgated in 2012.

There are numerous well-documented examples of introduced pathogens and invasive organisms that have impacted human health, including an outbreak of cholera in South America in the 1990s when the bacterium *Vibrio cholera* was introduced to local ecosystems through the release of ballast water.⁹ Invasive organisms such as the European green crab and Eurasian zebra mussel have had devastating effects on U.S. ecosystems and local economies.

The Volpe Center assisted the U.S. Coast Guard Environmental Standards Division (CG-0ES-3) with evaluating ballast water treatment systems installed on commercial vessels designed to prevent the introduction of ANS invasions into the waters of the U.S. The ballast water evaluations utilized innovative practices to ensure vessels met identified performance criteria. The work also included evaluating the state of the market for vessel air pollution control technologies.

9 Human Health Links to Invasive Species; <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7152145/>.



Volpe leads a team of marine engineers, marine biologists, and water treatment engineers to perform ballast water treatment system operational and biological efficacy evaluations.

Preventing ANS from entering U.S. waters is a critical and cost-effective way to protect coastal ecosystems. This work will lead to a safe means to ballast ships and provide more secure U.S. sea points of entry, and offer better protections of coastal ecosystems. **Sponsor: Environmental Standards Division (CG-0ES-3), and U.S. Coast Guard Headquarters**

Volpe Center Designs and Implements New Physical Security Systems at U.S. Merchant Marine Academy

The United States Maritime Administration (MARAD) supports the technical aspects of America's maritime transportation infrastructure, which includes promoting the overall health of the U.S. Merchant Marine.

To help ensure U.S. Merchant Marine Officers are properly trained to serve the marine transportation and economic needs of the United States, MARAD invests in the infrastructure, safety, and security of their training facilities. MARAD requested the Volpe Center to assist in the design and implementation of a new integrated physical security system at the U.S. Merchant Marine Academy (USMMA) in King's Point, New York, one of the nation's five service academies.

The Volpe Center is developing the campus-wide integrated physical security system, including over

Before and after images of secondary vehicle entry control point completed in 2020. Source: U.S. DOT Volpe Center

200 cameras, access control system, vehicle entry control points, repair of the fiber-optic infrastructure, cyber security certification of individual systems, upgrading exterior lighting to be more environmentally efficient, and emergency safety call boxes throughout the campus.

The system comprises wireless and radio fiber-optic technology, switches, and routers within a dedicated local area network. The Volpe Center is also replacing all the exterior lighting with more environmentally friendly LED lighting that is tuned to proper color spectrum of the video surveillance system.

Each year, the USMMA graduates approximately 230 midshipmen, with over 55 percent joining the Merchant Marine as officers on U.S. flagged vessels and over 20 percent serving actively in the U.S. Armed Forces and U.S. Coast Guard. These men and woman play a vital role in maintaining an essential part of our nation as the U.S. imports approximately 33 percent of the world's raw material, nearly exclusively on merchant vessels. Through the Volpe Center's efforts to improve the safety and security of the USMMA campus, the midshipmen are able to focus safely on their studies and the staff are able to focus on their mission to deliver quality education to students.

The Volpe Center is delivering technological advances that improve the safety and security for midshipmen and staff at USMMA while preserving the national historic building located there. **Sponsor: MARAD/USMMA**



CLIMATE SOLUTIONS AND SUSTAINABILITY

Source: Adobe Stock



U.S. DOT is tackling the climate crisis by ensuring that transportation plays a central role in the solution. The Volpe Center is a proven leader in helping the nation address its most pressing transportation-related energy and environmental challenges.

HIGHWAYS

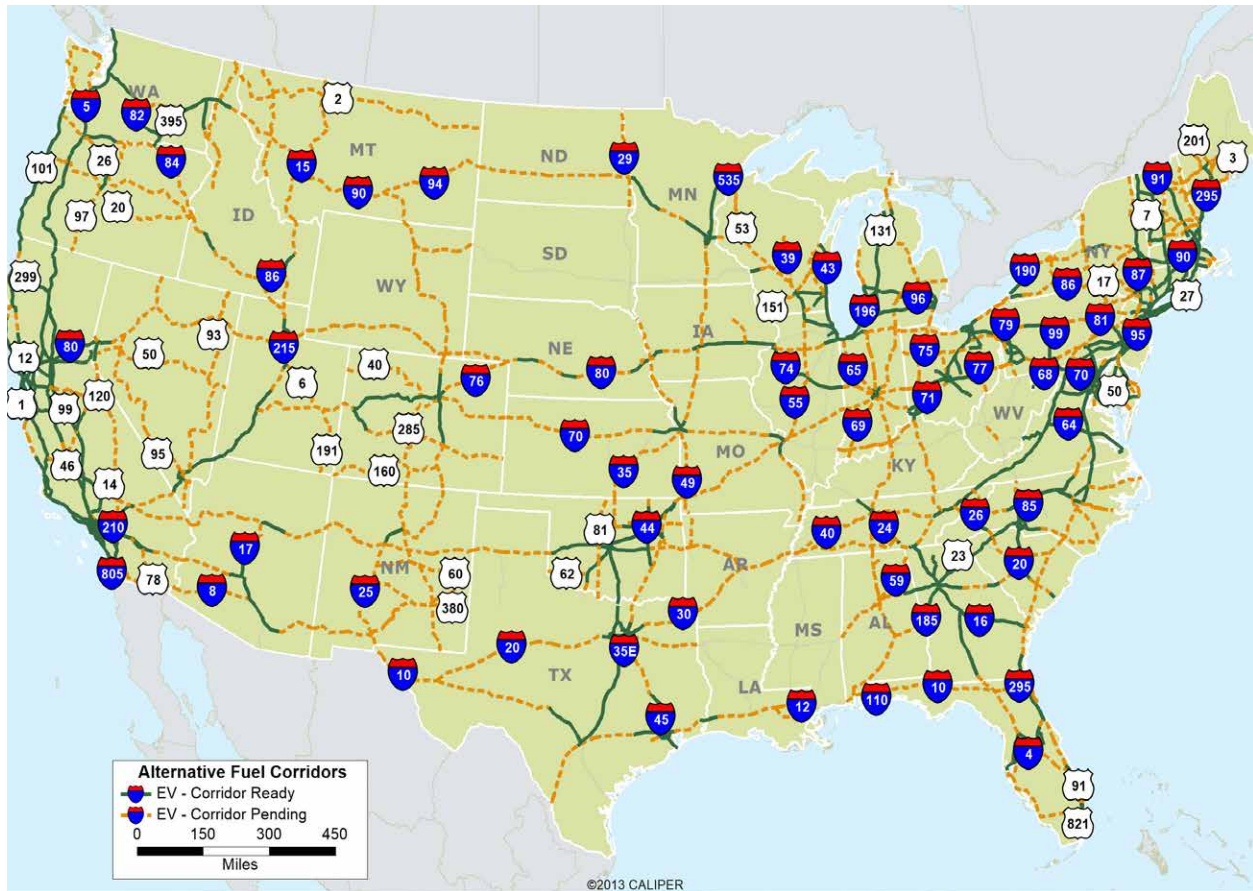
Improving Mobility by Expanding the Alternative Fuel Corridor Network

The demand for fuel-efficient vehicles by consumers and the need for a cleaner form of transportation are driving the growth of the alternative fuel vehicle market. Strategic federal investments in electric vehicle (EV) charging infrastructure can accelerate the transition to a cleaner transportation system and could be an impactful component of a national climate and infrastructure program.¹⁰ Section 1413 of the FAST Act requires the U.S. DOT to designate

alternative fuel corridors (AFCs) in strategic locations along major highways for plug-in EV charging, and hydrogen, propane, and natural gas vehicle fueling. FHWA has been working with federal, state, and local officials, as well as private industry to help plan, develop, and promote a national network of alternative fueling and charging stations along National Highway System (NHS) corridors. These corridors will enable commercial and passenger vehicles powered by clean, domestically produced alternative fuels to travel reliably between cities, regions, and the entire nation. FHWA is expanding this national network by adding new corridor designations annually.

On April 22, 2021, Secretary Pete Buttigieg announced the fifth round of designations for the AFC program during a press event with National Climate Adviser Gina McCarthy in Washington, DC. The Volpe Center assisted with the development of the Request for Nominations, general outreach and education for prospective applicants, corridor nomination proposal evaluations and selections, and the development and maintenance of the AFC program technical assistance products, resources, webinars, website content, GIS analysis, and corridor network maps. Round 5 included nominations from 25 states for 51 interstates and 50 U.S. highways/state roads.

¹⁰ M.J. Bradley & Associates and Georgetown Climate Center, [“Towards Equitable and Transformative Investments in EV Charging Infrastructure,”](#) March 2021.



To date, FHWA has solicited a total of 125 nomination proposal packages from state and local officials, resulting in AFC designations along portions/segments of 134 interstates and 125 U.S. highways/state roads, across 49 states and Washington, DC, covering more than 165,000 miles of the NHS.

Volpe staff contributed technical and programmatic expertise in developing alternative fuel and electric charging infrastructure, and provided contacts across the country who are developing and implementing alternative fuel initiatives from both the private and public sectors. Volpe's GIS expertise also assisted with program analysis and corridor highway mapping.

State departments of transportation and regional transportation planning agencies are the primary target beneficiaries of the program, but state environmental, energy, and economic development authorities and the traveling public will also benefit from this work. The benefits include lower regional vehicle emissions

Round 1-5 EV corridors. Source: U.S. DOT Volpe Center

to meet state climate and air quality goals, acceleration of public interest and awareness of alternative fuel options through national highway signage branding, and improved public health from the use of cleaner burning transportation fuels. **Sponsor: FHWA – HEPN**

Aggregating Data Sources to Improve Vehicle Emissions and Traffic Noise Analyses

Combining multiple streams of complex traffic data into a succinct and usable format for air quality and noise analyses is a challenging and time-consuming task. The complexity of this task multiplies as new telematics data sources become available for information like vehicle

speed. A typical data file that needs to be parsed and compared to other data files for aggregation is approximately 5 GB. Working with these files manually is impractical and prone to human error. Additionally, analysts have relied almost exclusively on transportation models to generate base-year traffic data, but using models rather than actual data has been an often-cited shortcoming of transportation emission and noise analyses.

To help address these issues, FHWA created the Database for Air Quality and Noise Analysis (DANA) tool to combine traffic data from existing data sources into a single database, and then process those data into properly formatted inputs to the Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator (MOVES) model and the FHWA's Traffic Noise Model Aide (TNMAide), which is used to determine the worst noise hour for roadway traffic noise studies.

Since early 2020, Volpe Center staff have supported FHWA in enhancing and updating the DANA tool to prepare it for initial public release. The DANA tool reduces the burden on state DOTs and MPOs for data processing and greatly simplifies and standardizes traffic data input for EPA MOVES and TNMAide. The DANA tool spares environmental analysts the task of assembling the data and enables the use of real-world, real-time inputs. Furthermore, the DANA tool helps ensure that environmental analyses across the entire country use a consistent set of traffic data and processing methods.

The Volpe Center developed and guided the beta testing plan and supervised the beta testing process. Volpe then developed a list of improvements based on the beta testing and finally implemented these improvements for the release version. Volpe experts in project management, software development, and data science contributed to the project.

The DANA tool beta testing was completed in 2020. Based on beta testing results, the first release was made public in July 2021 and a minor update is planned in early 2022. **Sponsor: FHWA Office of Natural Environment**



One case study produced as part of the FHWA HEPH project examines New York City's pilot cargo e-bike program. Source: New York City Department of Transportation

Driving E-Bike Research Efforts for the Federal Highway Administration

Electric bicycles or e-bikes have grown in popularity in recent years, a trend that has accelerated since the COVID-19 pandemic began in spring 2020. According to research from the NPD Group, sales of e-bikes in the U.S. increased 240 percent in 2021 compared to 2020.¹¹

Though there is an increased desire to integrate e-bikes into existing transportation and trail systems from both industry and advocates, a lack of research on the impacts of e-bikes on safety, access, and natural and cultural resources (e.g., erosion) has led to an inconsistent response by federal, state, and local governments. The Volpe Center is supporting the Federal Highway Administration Office of Human Environment (HEPH) and Western Federal Lands Highway Division (WFL) to fill these research gaps, inform e-bike-related decision-making, and enhance safety of all users through two projects.

¹¹ The Cycling Market Pedals Ahead in 2021, Reports the NPD Group; <https://www.npd.com/news/blog/2021/the-cycling-market-pedals-ahead-in-2021/>.

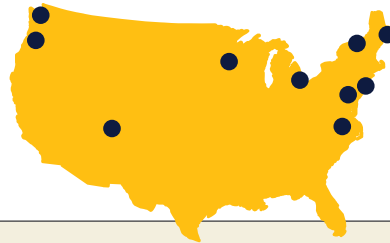
Studying Electric Bikes on Roads and Trails

E-BIKE INTEGRATION IS ANTICIPATED TO INCREASE

Sales of e-bikes increased by 240 percent from 2020 to 2021, making them the third largest cycling category in terms of revenue.



The projects include case studies from several locations including:



CONTRIBUTION TO U.S. DOT PRIORITIES

The FHWA Western Federal Lands Highway Division project is important and aligns with U.S. DOT priorities because it contributes to:



Enhanced safety of all users (road, trail, etc.)



Improved visitor experience



Evidence-based decision making



Convened public lands managers and stakeholders to develop and prioritize study objectives



The HEPH project developed 10 case studies that described e-bike management practices and produced a literature review addressing e-bike impacts. The WFL project developed an outreach and engagement strategy for public land managers, academic experts, and public lands stakeholders; created a study methodology to guide research activity; conducted a literature review; produced case studies to build on

existing literature; and coordinated with Volpe Center human factors experts and public lands managers and advocates in the Boston region to develop field studies to collect primary data to advance the research outlined by the study methodology.

Volpe Center staff produced the literature review, conducted interviews with stakeholders, and developed

outreach materials for the HEPH project. For the WFL project, the Volpe team developed the study methodology; conducted office and field research, including the field studies; and convened technical review groups. **Sponsor: FHWA Office of Human Environment (HEPH) and FHWA Western Federal Lands Highway**

PUBLIC TRANSIT

Estimating Greenhouse Gas Emissions from Transit Projects to Further Environmental Goals

In April 2021, President Biden set a goal to cut the United States' greenhouse gas (GHG) emissions by as much as 50-52 percent from 2005 levels by 2030. This target is consistent with the President's goal of achieving net zero GHG emissions economy-wide by no later than 2050. The transit industry can contribute to this initiative by carefully considering the effects of proposed transportation projects on global climate change. The National Environmental Policy Act (NEPA) requires federal agencies, such as the Federal Transit Administration (FTA), to evaluate and disclose such information regarding proposed actions.

To aid this effort, the Volpe Center collaborated with FTA to develop the Greenhouse Gas Emissions Estimator, a tool used by transit agencies to calculate project-specific GHG emissions to inform their NEPA analyses. The emissions estimator allows users to input general information about a project and receive an estimate of the partial life cycle GHG emissions generated from the construction, operation, and maintenance phases across select transit modes. The tool can be used for a broad range of transit projects and generates coarse, but informative estimates of GHG emissions.

The emissions estimator was initially developed and released in January 2017. In April 2021, FTA provided an update of the tool (Estimator 2.0) to include more current emissions data. The Volpe Center assisted in

the update by collecting and analyzing updated GHG emission factors and transit use data. Volpe staff also led the redesign of the estimator tool to make it more user-friendly.

Estimating the GHG emissions of a proposed action or transportation project provides important information to transit agencies and decision makers that will help reach the Administration's goal of cutting emissions by 2030. As for the tool itself, FTA is considering future enhancements to the emissions estimator and anticipates developing a version 3.0 for release in 2022.

Sponsor: FTA Office of Environmental Programs

Electrifying Transit at Grand Canyon National Park with Nationwide Implications

Grand Canyon National Park (GRCA) plans to renew its bus fleet as interest and support for electrifying transit operations across the United States continues to gain momentum, an effort that aligns with President Biden's [Executive Order on Tackling the Climate Crisis at Home and Abroad](#), which includes procurement of clean and zero-emission vehicles for the federal fleet. This project incorporates two of U.S. DOT's priorities—transformative infrastructure, and resilience and addressing climate change.

Battery electric buses (BEBs) have zero tailpipe emissions and operate more quietly than GRCA's compressed natural gas (CNG) buses; however, they require different energy infrastructure (electric charging instead of fuel storage and delivery systems) and may have limited range. Technical analysis by the Volpe Center helped determine how to best introduce overnight-charge, extended-range BEBs to GRCA operations, leverage benefits, and ensure equivalent levels of service. Project timing coincided with rebuilding the GRCA bus maintenance facility, enabling the Volpe team to advise National Park Service (NPS) staff on different configurations for charging infrastructure. The Volpe team and NPS staff explored the use of on-site solar and energy storage to maintain



operations when power outages or similar disruptions occur, and introduced the long-term potential for BEBs to become an energy source in periods of extreme high demand.

The Volpe Center leveraged its expertise in the fields of BEB technologies, energy supply chains, and strategic implementation planning. A high-level analysis of all GRCA bus routes captured existing conditions related to total bus mileage, operating hours, peak passenger loading, elevation changes, and the average peak temperature during July (peak season for park visitation). The Volpe team coordinated with GRCA staff and the shuttle operations provider to understand daily operations, confirm the viability of electrifying each route within the park, and identify challenges for BEBs.

GRCA used Volpe's analysis results to support an application for grant funding from the Nationally Significant Federal Lands and Tribal Program (NSFLTP) to implement BEBs and related infrastructure along the park's Village Route. If awarded, GRCA may be able to replace 10 CNG-powered buses with 10 BEBs, which will provide new insights into real-world operating range during typical use and peak visitation, including critical lessons about full-fleet electrification. Recent results included exploring how to accommodate electric vehicle service equipment, or charging equipment, within the bus maintenance facility and to support resiliency and energy management.

As BEB technology advances and the park continues to gain experience, converting the entire 33-bus system to electric power may be possible.

Grand Canyon National Park looks to replace its current compressed natural gas fleet of buses (pictured) with zero-emission battery electric buses. Source: NPS.

More broadly, as NPS looks ahead to operating a fully electrified fleet, planning for long-term growth in power demand is necessary. The transition to BEBs must include engaging the energy supply chain, adopting power demand management, and building in resilience to ensure goals and benefits can be met through the deployment of the technology. Volpe support in evaluating BEB suitability may also provide an opportunity to scale up GRCA's ability to operate additional buses or identify other park units where BEBs are viable. **Sponsor: NPS regions 6, 7, 8**

AVIATION

Creating a Green and Sustainable Remediation Framework to Reduce the Footprint of Environmental Cleanup at FAA Facilities

Cleaning up hazardous waste sites uses significant energy, water, and other materials and natural resources. For example, heavy-duty construction equipment, commonly used in facility decommissioning and contaminated soil removal is often powered by diesel fuel and emits a complex mixture of air pollutants and greenhouse gases. Additionally, many

long-term remedies, such as groundwater pump-and-treat systems or thermal soil treatment systems, can consume massive amounts of energy from fossil fuel-powered utilities for years, sometimes decades. With over 800 environmental cleanup sites within the FAA's Environmental Cleanup (ECU) Program, the overall environmental impact is considerable.

FAA sought the Volpe Center's expertise in creating implementable procedures and decision-making tools to help guide the sustainable cleanup of contaminated sites. Volpe helped stand-up, and has supported many of FAA's environmental programs, including the ECU Program, since their inception in the late 1980s.

The objective of this project is to develop a National Green and Sustainable Remediation (GSR) framework that promotes green and sustainable principles and integrates environmental, social, and economic considerations into environmental cleanup decisions. The desired framework would incorporate quantitative and qualitative tools that help site managers choose remedial alternatives having the least impact on climate change, land resources, materials consumption, and

Although FAA cleanup projects are designed to improve environmental conditions at a site, remediation technologies like Thermal Conductive Heating (TCH), which is being used to treat contaminated source areas at a former Jet Fuel Farm at the FAA William J. Hughes Technical Center Superfund Site, can scar the landscape, generate waste, emit greenhouse gases, and other pollutants, and consume enormous amounts of energy – upwards of \$2M/year in energy costs, alone. (Source: FAA and United States Coast Guard).



waste generation. The guidance would be applicable to all FAA ECU Program activities that occur at air traffic control facilities across the nation.

Volpe staff conducted a review of existing GSR standards, guidance, and tools and developed the framework, including a comprehensive implementation guidance document. In addition, a Volpe team is preparing training materials to be used for implementing GSR guidance across the FAA's ECU Program.

The draft guidance and framework were submitted to FAA in August 2020 and are awaiting dissemination to field organizations, the intended users, for their review and concurrence. Volpe staff have also engaged the FAA sponsor on expanding the GSR framework to incorporate resiliency into site cleanups.

Implementing GSR practices across the FAA Environmental Cleanup Program will contribute to meeting FAA and government-wide sustainability, equity, and climate change policy goals. Once implemented, the environmental footprint quantification tools included in the guidance will allow the FAA to document, monitor, and share metrics describing reductions in environmental impacts (e.g., tons of greenhouse gas emissions reduced, gallons of water saved, acres of land restored, etc.). **Sponsor: FAA, EOSH Services - AJW-231, Environmental Cleanup Program**

Analyzing the Suitability of LED Lamps for Airport Operations

Airport lighting is critical for surface operations, landings, and departures in reduced-visibility conditions and at night. Light-emitting diode (LED) lamps and appropriate fixtures have become increasingly popular in general because of their substantially higher luminous efficacy and usable lifetime compared to incandescent lights. LED lamps are also more cost effective to operate than conventional incandescent or halogen lamps. Manufacturers of airport lighting systems are transitioning to LED lamps to comply with the 2007



LED lamps for airport lighting are seen side-by-side with their incandescent counterparts at the Aviation Weather Research Facility. Source: U.S. DOT Volpe Center

Energy and Independence and Security Act, which mandates the phase-out of incandescent lamps of certain wattages, but further research is required on the suitability of LED lamps for aviation use.

The FAA approached the Volpe Center about conducting research at the Aviation Weather Research Facility (AWRF) in Sandwich, MA, using a visual-spectrum camera, weather sensors, and select LED airport lighting. A Volpe team set up a simulated runway about 2,400 feet long, with a camera and visibility-measuring equipment at one end and two rows of mixed LED and incandescent lighting. Volpe staff also placed and collected data from two additional visibility sensors. Volpe then designed and implemented an automated data collection system to record and archive video data and visibility data, and performed continuous data collection from April 2019 to January 2020. The video data was used to support a human observer's evaluation of the appearance of the lamps under a representative range of weather and visibility conditions. However, by necessity, this human review was limited to a relatively small number of images, and did not take advantage of the full spectrum of available data.

In order to more fully utilize the entire scope of available data, Volpe developed and implemented an automated, quantitative methodology to analyze

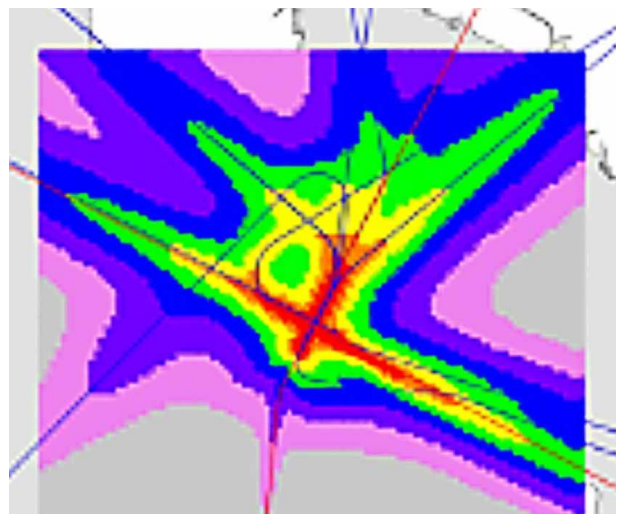
hundreds of hours of low-visibility video data and assess the relative appearance of the lamps. Volpe then prepared a comprehensive report on the test design, methodology, and analysis results and published the report in March 2021. Volpe analysis revealed the LED lamps tested were easier to see, on average, than the incandescent bulbs they were designed to replace under all weather and visibility conditions.

The results of this research provide the FAA and other stakeholders with the confidence that LED lamps can be used to replace incandescent lamps without a loss of visibility in bad weather. This effort supports FAA's safety objectives and helps address climate change due to the reduction in energy use. **Sponsor: FAA**

FAA Makes Environmentally Responsible Decisions Using Aviation Environmental Design Tool

The Aviation Environmental Design Tool (AEDT) is a critical element in the FAA's federally required environmental review process, implemented in response to increasing air traffic and the modernization of the nation's aviation infrastructure. AEDT

Sample noise exposure contour. Source: U.S. DOT Volpe Center/FAA



dynamically models aircraft performance in space and time. With over 1,000 licenses in 46 countries to date, AEDT has become the de facto global reference model for considering the interdependencies between aircraft-related fuel burn, noise, and emissions, and their collective environmental effects.

Data scientists and software developers at the Volpe Center have led the development and systems integration of AEDT. The Volpe team collaborates with the FAA and aviation manufacturers, stakeholders from the U.S. Environmental Protection Agency (EPA), the International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP), the European Organization for the Safety of Air Navigation (EUROCONTROL), the FAA ASCENT Center of Excellence—a cooperative aviation research organization co-led by Washington State University, Massachusetts Institute of Technology, Georgia Tech, and many other universities and organizations to ensure the best-available data and methods are applied by the model. In addition to model development, Volpe Center engineers support a number of analysis efforts with AEDT.

The U.S. government uses AEDT to understand the noise and emissions changes associated with operational and procedural changes, such as NextGen, as well as to inform domestic and international policy discussions. The model is also used to quantify emissions reductions associated with the replacement of airport equipment with low-/no-emission alternatives in support of FAA's Voluntary Airport Low Emissions (VALE) program.

AEDT Series 3, first made available to the public in fiscal year 2019, was a transformative release of the software that significantly improved the fidelity of aircraft performance, fuel burn, and emissions modeling at low speed and altitude. AEDT Version 3d was released to the public in March 2021. AEDT 3d users have access to new air quality modeling options, including a complete interface to EPA's AERSURFACE land surface characteristics tool. The updated program also presents measured data on aircraft-produced non-volatile particulate matter for the first time, thereby eliminating the need to estimate those data.

The FAA will be able to make environmentally responsible decisions on federal actions to improve the safety and efficiency of the NAS, while being responsive to community concerns on aircraft noise by relying on results generated with AEDT. Additionally, AEDT supports a wide array of aviation research, including the analytical capability to support policies and standards being developed by ICAO. This sophisticated platform has positioned the United States as a leader in providing objective, data-driven policy input to ICAO/CAEP. **Sponsor: FAA Office of Environment and Energy**

PUBLIC LANDS

National Park Service Automated Shuttle Pilots

For decades, the U.S. DOT has supported the NPS in their work to enhance visitor access and safety at national parks. In spring 2021, NPS launched pilots to test automated shuttles at two NPS locations—the first-ever demonstrations on any recreational public lands in the country. Conducted at Yellowstone National Park and Wright Brothers National Memorial, these demonstrations allowed NPS to test the suitability of emerging automated, electric vehicle technologies in public lands, with the long-term goals of enhancing access and encouraging green, car-free trips.

Since 2018, the Volpe Center has worked with NPS to develop a strategy to help national parks adapt to and proactively address emerging mobility trends, including automated vehicles, electric vehicles and charging stations, micromobility, traveler information technologies, and ridehailing. The Volpe Center provides extensive technical assistance to the NPS Emerging Mobility Program, including at all stages of the automated shuttle pilots, from concept to planning and evaluation.

These pilots involved the deployment of low-speed automated shuttles in different operational settings, which will provide NPS and industry leaders with an opportunity to assess the suitability of these technologies for use on public lands. The pilot at



The electric driverless demonstration at Yellowstone National Park. Source: National Park Service

Wright Brothers National Memorial, the Connected Autonomous Shuttle Supporting Innovation, began on April 20, 2021, and ran through July 16, 2021. The Wright Brothers pilot was conducted in partnership with the North Carolina DOT. The automated shuttle pilot at Yellowstone National Park began on June 9, 2021. The Electric Driverless Demonstration at Yellowstone transported visitors to and from the lodges and campground in Yellowstone's Canyon Village through August 31, 2021.

In addition to coordinating with stakeholders and providing planning support, the Volpe Center provided technical expertise on automated shuttle technologies to NPS staff, including developing reference materials, presenting to NPS audiences, developing approaches

for risk management, and collecting survey data on passenger experiences. Following the completion of the automated shuttle pilots, Volpe staff conducted a detailed evaluation to assess the performance of the shuttles and their automated technology based on a range of metrics collected during the pilots, including shuttle ridership, route performance, battery performance, and interventions from the shuttles' safety operators.

With Volpe Center support, NPS aims to use these pilots to gain valuable insight into potential barriers related to emerging mobility technologies. Identifying and addressing those barriers now will help inform and support the successful longer-term testing and implementation of these technologies to enhance visitor experience and resource protection at national parks across the country. **Sponsor: National Park Service—Washington Support Office (WASO) Transportation Branch**

Developing Air Tour Management Plans at National Parks to Protect Natural Resources while Ensuring Flight Safety

Air tour management plans (ATMPs) are an essential tool for protecting the natural and cultural resources of national parks and tribal lands and ensuring the safety of flight operations within or abutting national parks over which commercial air tours are conducted. The National Parks Air Tour Management Act (NPATMA) requires the FAA, in cooperation with the NPS, to establish ATMPs for parks or tribal lands where air tour operations occur or are proposed. In May 2020, the U.S. Court of Appeals for the District of Columbia Circuit ordered FAA and NPS to submit a schedule for bringing eligible parks into compliance with NPATMA by August 2022 or to show specific concrete reasons why doing so will take longer. In order to comply with the schedule approved by the court in November 2020, the agencies are developing ATMPs for 24 parks at the same time, and, to the maximum extent possible, consolidating administrative processes and streamlining activities under NEPA, in order to complete all of the ATMPs by August 2020.

The Volpe Center's Policy, Planning, and Environment Technical Center is providing substantial project management and technical support to the FAA and NPS for the concurrent development of the ATMPs. Support includes subject-matter expertise on NEPA, Section 106 of the National Historic Preservation Act (Section 106) including tribal consultation, and Section 7 of the Endangered Species Act requirements, noise modeling, data collection, program management support and interagency coordination, and the development of public engagement materials.

As of September 2021, the Volpe Center has provided support to the agencies' efforts to release 11 draft ATMPs and a corresponding public meeting for each plan, as well as initial work on the remaining 13 parks. The draft ATMPs provided to date are: Mount Rainier

National Park, Death Valley National Park, Everglades National Park, Olympic National Park, Arches National Park, Bandelier National Monument, Bryce Canyon National Park, Canyonlands National Park, Glacier National Park, Great Smoky Mountains National Park, and Natural Bridges National Monument. In addition, the Volpe Center continues to work with the agencies on Section 106 and Section 7 consultation requirements.

Looking forward, the Volpe Center will continue to support the FAA and NPS in releasing the remaining 13 draft ATMPs in accordance with the court approved schedule. This project combines the mission of safety in the skies with protection of significant natural and cultural resources in national parks and tribal lands.

Sponsor: FAA and NPS

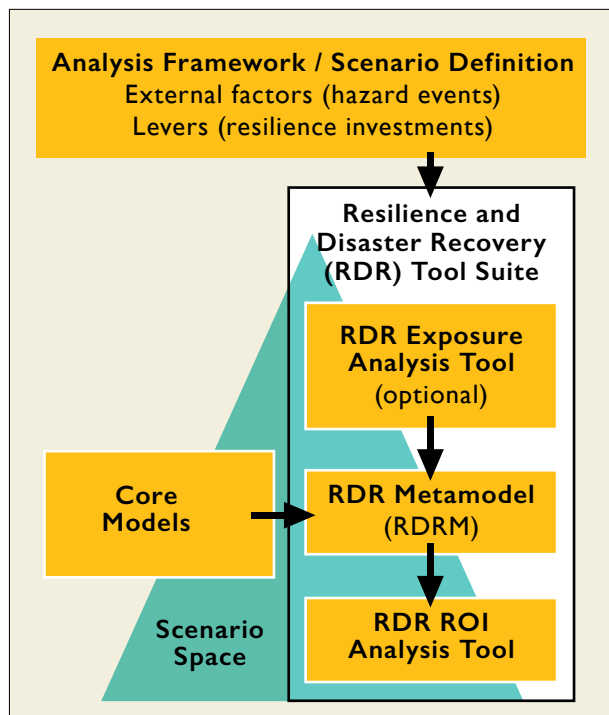
MULTIMODAL

Developing a Tool Suite to Address Resilience Return on Investment in Transportation Infrastructure

A study conducted in 2019 revealed that at least \$6 are saved for every \$1 invested in reducing vulnerability to natural hazards.¹² In order for stakeholders to accurately assess the value of resilience in future infrastructure investments, they must be able to understand and incorporate the costs and benefits of resilience into the transportation planning decision-making process. This is a difficult evaluation to make, considering that future conditions and hazards are highly uncertain.

The Resilience and Disaster Recovery (RDR) Tool Suite was developed by the Volpe Center in support of the FHWA and in partnership with the Office of the Assistant Secretary for Research and Technology

¹² National Institute of Building Sciences; *Natural Hazard Mitigation Saves: 2019 Report*, <https://www.nibs.org/reports/natural-hazard-mitigation-saves-2019-report>.



This diagram shows the structure of the RDR Tool Suite. Source: U.S. DOT Volpe Center/FAA

(OST-R). The RDR Tool Suite is designed to help transportation agencies explore the scenario space for transportation disruption and mitigation and to estimate the return on investment (ROI) of resilient roads and bridges across a range of uncertain future hazards (e.g., floods, earthquakes, etc.) in the context of long-range transportation planning. The RDR Tool Suite leverages standard travel demand modeling that is widely used by transportation agencies. Volpe developed this tool suite from its conceptualization through to implementation. Phase 1 of the project is complete; the beta version of the RDR Tool Suite was completed in spring 2021. Phase 2 is underway, and will include further technology transfer and tool suite piloting, and refinement of the tool for public release, targeted for FY 2022.

During development of the RDR Tool Suite beta version, Volpe coordinated a pilot study in the Hampton Roads area of Virginia in collaboration with the Hampton Roads Transportation Planning Organization (HRTPO), the Hampton Roads Planning

District Commission (HRPDC), and the Virginia DOT. These agencies are continuing to pilot the tool during Phase 2. HRTPO intends to use results from the RDR Tool Suite pilot to inform project prioritization for its long-range transportation plan.

State and federal agencies need to determine which assets will provide the best ROI when considering transportation infrastructure resilience. The RDR Tool Suite will provide transportation agencies with the tools necessary to evaluate the ROI provided by a set of resilience investments across a range of transportation assets and uncertain future hazard conditions, and for ranking those projects based on performance. Reducing transportation infrastructure vulnerability advances the U.S. DOT's goals of enhancing resilience and addressing climate change.

State DOTs and MPOs are anticipated to employ the RDR Tool Suite to:

1. Assess network effects of hazards
2. Assess resilient asset investment costs and benefits
3. Communicate resilience costs and benefits
4. Assess relative performance of resiliency investment options
5. Inform project prioritization

Sponsor: Phase 1 (2018-2021), sponsored by FHWA in partnership with OST-R (this was an OST-R priority project funded by FHWA). Phase 2 (2021-2022), sponsored by OST-R, in partnership with FHWA (continued engagement/input).



Adobe Stock

New Congestion Mitigation and Air Quality Improvement Tools for Estimating Emissions Benefits from V2I/ITS and Intermodal Projects

The Congestion Mitigation and Air Quality Improvement (CMAQ) Program provides funding to state and local governments for transportation projects and programs in air quality nonattainment and maintenance areas to help meet the requirements of the Clean Air Act. CMAQ funded projects must demonstrate that they will provide emissions reductions.

Since 2015, the Volpe Center has supported FHWA's Office of Natural Environment in developing the CMAQ Emissions Calculator Toolkit (CMAQ Toolkit), a suite of spreadsheet-based tools that helps agencies estimate emissions benefits of their projects. Volpe's expertise in emissions and congestion modeling and understanding of FHWA's priorities and practices enabled the development of easy-to-use tools for a wide range of stakeholders.

The CMAQ Toolkit currently includes 12 tools, covering over 25 project types, including transit service expansion, alternative fuel vehicle and infrastructure, diesel retrofits, and bicycle and pedestrian improvements. Tool development in 2021 focused on vehicle-to-infrastructure (V2I) and intelligent

transportation systems (ITS) projects. V2I/ITS projects can improve air quality by smoothing the drive cycle of vehicles (i.e., less stop-and-go and idling). In addition to air quality benefits, these projects can also help reduce traffic congestion. The adaptive traffic signal control (ATCS) systems tool, which was released in March 2021, models projects that synchronize traffic signals in real time. Two additional V2I/ITS tools will be released soon: electronic and opening road tolling and travel advisories.

Development efforts in 2021 also concentrated on projects at ports and construction sites and on intermodal freight facilities. The construction and intermodal equipment, which is under development, will estimate emissions benefits from retrofitting off-road equipment, such as gantry cranes, drayage trucks, and tractors. The newest tool being developed, intermodal facilities and projects, focuses on estimating the emissions benefits from shifting freight movements (ton-miles or vehicle miles traveled) off of highways to other modes, including rail, marine, and air. These two tools will complement the locomotive and marine retrofit and replacement tool, released in November 2020, which models engine retrofits or repower/replacement for locomotives and marine vessels.

These new tools will help transportation agencies quantify emissions benefits for a broader range of projects and expand the reach and consistency of the CMAQ program. **Sponsor: FHWA, Office of Natural Environment**



Updating the FHWA Emergency Relief Manual

Natural disasters and catastrophic failures damage transportation routes that provide vital access to economic opportunities, education, healthcare, and other essential needs, as well as cause severe disruptions to transportation services and the supply chain. In 2020 alone, there were 22 separate weather and climate disasters totaling \$95 billion in damages.¹³

To help rebuild and repair federal-aid highways and federal roads damaged by natural disasters and catastrophes, the FHWA Emergency Relief (ER) Program receives \$100 million in funding annually,

The updated Emergency Relief Manual will provide guidance to state DOTs and transportation agencies on the ER process and how to apply for funds. The picture is of a heavily damaged Alaskan roadway caused by the 2018 earthquake. Source: FHWA

authorized under 23 U.S.C. 125.¹⁴ Congress also periodically provides additional funds for the ER program through supplemental appropriations.

The FHWA ER Program provides funding for the repair or reconstruction of highways and roads that have suffered serious damage from a natural disaster or catastrophic event. Funding is made available under two programs: the Emergency Relief for Federal-Aid Highways (ERFA) Program and the Emergency Relief for Federally Owned Roads (ERFO) Program.

¹³ 2020 U.S. billion-dollar weather and climate disasters in historical context; <https://www.climate.gov/disasters2020>.

¹⁴ Emergency Relief Program; <https://www.fhwa.dot.gov/programadmin/erelief.cfm>.

FHWA Division Offices, state transportation agencies, federal land management agencies, federally recognized tribes, and local government entities all need relevant information to fulfill their ER responsibilities effectively and efficiently. At present, the ERFA and ERFO programs provide guidance through two separate documents, the 2013 Emergency Relief Manual, and the 2014 Emergency Relief for Federally Owned Roads Disaster Assistance Manual.

FHWA engaged the Volpe Center to update and modify the Emergency Relief Manual, consolidating it with the Emergency Relief for Federally Owned Roads Disaster Assistance Manual and enhancing the information presented for both programs. The goal is to strengthen the administration and oversight of the ER program and to ensure the effective use of limited ER funding for eligible projects. Once published, the updated manual will serve as a step-by-step guide to help transportation agencies efficiently and effectively navigate the ER process and access ER program funds.

The Volpe Center team drafted and designed the new manual layout and worked with the Emergency Relief Team to reconcile, update, and consolidate content from the prior manuals. Volpe also addressed detailed feedback from Federal-Aid and Federal Lands Highway Division Offices to further revise the manual. Additionally, Volpe developed related communications materials, including an outreach and stakeholder engagement plan, a one-page flyer, frequently asked questions, and a presentation template that will be used for the rollout of the new document.

The Volpe Center team delivered a completed draft of the manual to FHWA's Emergency Relief Team in March 2021. The manual is now going through FHWA legal and good guidance review, with planned publication in 2022. **Sponsor: FHWA Emergency Relief Team ["Federal Highway Administration, Office of Infrastructure, Office of Stewardship, Oversight and Management, Emergency Relief Team"]**

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TRANSFORMATIONAL INNOVATION

Source: Adobe Stock



The U.S. DOT Volpe Center works in collaboration with the Office of the Secretary, Departmental operating administrations and offices, other federal agencies, and the broader transportation community to advance transportation innovation for the public good.

PUBLIC TRANSIT

Increasing Efficiency and Productivity of Transit Operations with Automated Bus Technology

Automation technologies have the potential to greatly improve transit bus operations and services. FTA began a research effort to understand the effects of automation with the goal of improving safety of operations, increasing efficiency and productivity, and enhancing customer experience and satisfaction. The Volpe Center has aided this effort since 2016 by supporting enabling research, integrated demonstrations, strategic partnerships, and knowledge transfer/stakeholder engagement/technical assistance—the four work areas identified in the [Strategic Transit Automation Research \(STAR\) Plan](#), released by FTA in 2018.

Since that time, Volpe helped launch the Transit Bus Automation Community of Practice (CoP),

released quarterly updates on the automated transit bus activities, and produced website content on FTA-funded and managed transit bus automation demonstrations and pilots. Volpe also assisted U.S. DOT grantees working on transit bus automation pilots in identifying public venues (e.g., the Automated Road Transportation Symposium 2021) to share the findings from their work. Drawing from expertise across the Center, Volpe has provided technical assistance that has included reviewing project management plans, data management plans, survey instruments, and other inputs as projects are developed.

In 2021, a Volpe team assisted with publishing five FTA documents—[Assessing Transit Providers' Internal Business Case for Transit Bus Automation, Insurance and Liability for Automated Transit Buses: State of the Practice Review, Survey Research for Automated Shuttle Pilots: Issues and Challenges, Transit Bus Automation Quarterly Update](#), and [Transit Bus Automation Market Assessment–2021 Update](#). Research for these reports was based on literature reviews and stakeholder engagement, including phone interviews with representatives from transit agencies, industry, and other organizations. Most of Volpe's research support is based on identifying challenges and how they are being addressed, characterizing the state of pilots and the market, and providing background to FTA staff, transit agency stakeholders, and other state or local officials.

Volpe continues to facilitate FTA Transit Bus Automation CoP meetings with grantees to connect the various teams with each other and glean information on the challenges and issues they are



An “AV Star” bus built by GreenPower and equipped with an automated driving system from Perrone Robotics; the bus was tested as part of the Jacksonville Transportation Authority’s “Test & Learn” program. Source: GreenPower Motor Company

encountering, how they are addressing them, what lessons they have learned, and more. The Volpe Center is currently developing reports on automated transit bus equity and accessibility. Volpe’s support is integral to FTA’s goals of identifying opportunities and resolving barriers to transit automation deployment, conducting research to achieve safe and effective deployments, and transferring knowledge to the transit stakeholder community. **Sponsor: FTA**

Volpe Creates an Impact Assessment Framework to Articulate the Benefits of Cooperative Driving Automation

Safety and congestion are significant concerns on U.S. roadways. In 2019, there were 36,096 vehicle-related traffic fatalities, an estimated 2.74 million injuries, and 4.8 million police-reported property-damage-only crashes in the United States.¹⁵

¹⁵ NHTSA. (2020). Overview of Motor Vehicle Crashes in 2019 (Research Note DOT HS 813 060; Traffic Safety Facts). NHTSA. <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813060>.

Cooperative driving automation (CDA) is a significant area of U.S. DOT research and deployment testing. Potential benefits include improved safety and highway efficiency, as well as reduced energy use and emissions. A safe and efficient interaction between vehicles and infrastructure has the potential to reduce crashes and congestion.

The FHWA Turner Fairbank Highway Research Center asked the Volpe Center to create and apply an impact assessment framework to identify the types of safety, mobility, and other benefits that CDA will bring when applied to various transportation modes. This framework will lead to a methodology for scaling up the results of research studies, enabling an improved understanding of CDA impacts at the national level. Expected users include those responsible for highway investments, including state DOTs, MPOs, and local infrastructure operators.

FHWA’s objective with this effort is to articulate the benefits and drawbacks of CDA, and then use the framework to guide U.S. DOT research in collecting the right data to calculate benefits. This project will guide infrastructure investments necessary to enable effective use of CDA, ensuring the promised benefits of automation are fully realized.

This project draws on the Volpe Center’s experience in impact assessment for automation, using as a

Passenger vehicles and a heavy truck in the Cooperative Automation Research Mobility Applications (CARMASM) research fleet. Developed by FHWA, CARMA is open-source software that supports cooperative driving automation. Source: FHWA





starting point the framework that was developed in an earlier automation project. The team then reviewed existing research, including past detailed assessments of relevant automation and connected driving projects, as well as past efforts at making national-level estimates. Volpe project team members have experience in detailed vehicle trajectory data typically used for mobility, energy, and emissions analysis, as well as in economics. The latter is necessary for understanding secondary impacts, and for rolling up the individual vehicle and corridor level impacts to a national level.

CDA has the potential to reduce crashes, injuries, and fatalities caused by human error and may provide a significant mobility improvement, enabling more efficient use of highways, as well as supporting economic growth and productivity with fewer expensive expansion projects. This project began in spring 2021, with initial results expected in early 2022.

Sponsor: FHWA Turner-Fairbank

HIGHWAYS

Quieting National Parks through Quieter Roadway Pavements

The National Park Service (NPS) considers the soundscape within our national parks intrinsically important to visitor enjoyment, and roadway traffic is

Quieter pavement acoustic data collection in Death Valley National Park. Source: U.S. DOT Volpe Center

one of the most common sources of noise detracting from the natural environment and landscape. The Volpe Center is assisting the NPS Natural Sounds and Night Skies Division (NSNSD) in their investigation of quieter pavement as a noise abatement measure.

Quieter pavements can be a good alternative to noise barriers because they reduce noise at the source, which can translate to noise reduction at all distances, and they do not disrupt views or animal traffic patterns. The noise reductions provided by these pavements can have a major positive impact on the overall park soundscape.

The Volpe Center is assisting NSNSD in a five-year assessment comparing the noise reduction benefits of four common surface treatments used by NPS for pavement preservation. Conducted in Death Valley National Park, the five-year study is designed to determine which treatments, alone or in conjunction with other strategies, may provide the most benefit in terms of noise reduction over time.

The study uses three complementary acoustic measurement methods to study the noise characteristics of those pavements:

- On-board sound intensity (OBSI): A measure of the tire-/pavement-generated noise at the source, using an intensity probe mounted on a test vehicle.

- Roadside measurements: A more traditional measure of the noise generated by vehicles near the roadway, using a microphone positioned 50 feet from the near traffic lane.
- Effective flow resistivity (EFR): A measure of acoustic flow resistivity, which determines how much sound energy the pavement will reflect or absorb.

In addition, binaural recordings and photogrammetry data are collected to document and provide additional information to park managers for outreach and communication purposes.

Volpe experts are using the FHWA's Traffic Noise Model (TNM) and Volpe's Advanced Acoustic Model (AAM) to compare results for the different pavement types, and to extrapolate the data to locations and conditions not measured. The information collected and model results will help park managers across the country understand and appreciate how quieter pavements may be of benefit in their specific locations and circumstances.

NPS recently published the results for the acoustic data collected one year after the test pavement treatments

were applied, showing a 2.5-dB variation in noise levels among the four different treatments.¹⁶ A decrease of 3 dB is equivalent to removing 40 percent of the average daily traffic from the roadway, or reducing by up to 40 percent the distance at which the roadway sounds will be audible to humans and some wildlife species.

The Volpe Center initiated a similar five-year study in Yellowstone National Park in August 2021. **Sponsor: NPS Natural Sounds and Night Skies Division (NSNSD)**

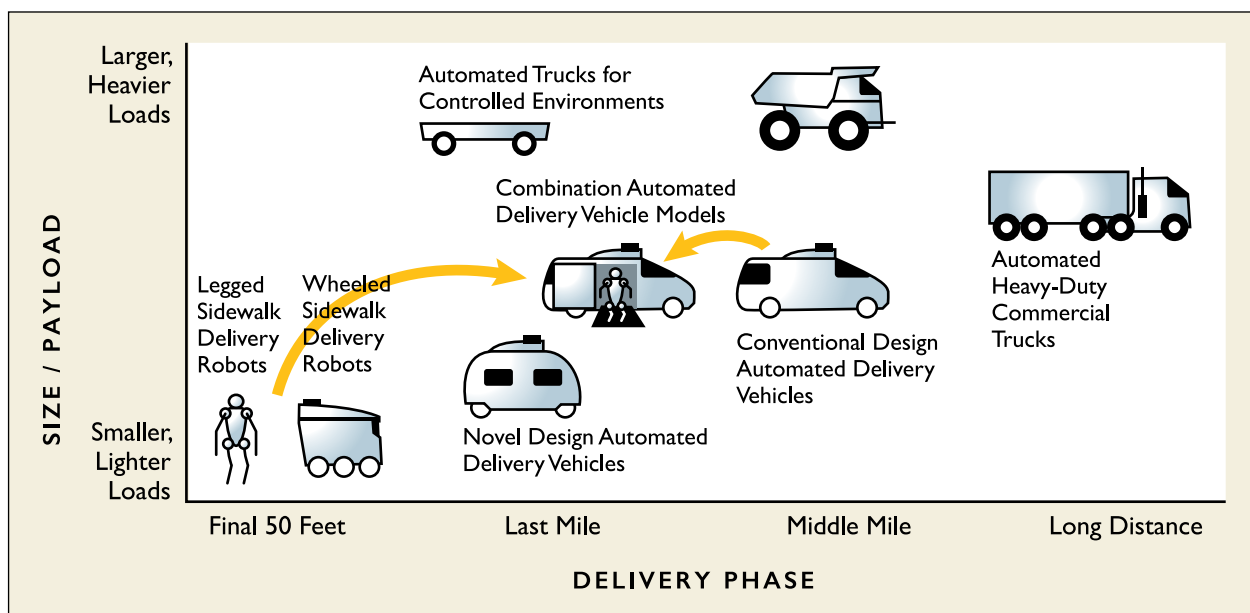
SUPPLY CHAIN

Understanding the State of Emerging Automated Technologies in Urban Freight Delivery

It is no secret that consumers have chosen online ordering and delivery over in-person shopping increasingly in recent years, especially since the start of the COVID-19 pandemic. Furthermore, things like two-

Depiction of automated delivery vehicle and device concepts.
Source: U.S. DOT Volpe Center

16 Published Report – (Code: 2275554); <https://irma.nps.gov/DataStore/Reference/Profile/2275554>.



day, next-day, or same-day delivery and “contactless” delivery have become the new normal. Automation technologies may help reduce the costs of delivery and improve efficiency of urban freight delivery. To understand concepts and activities related to automated delivery vehicles and devices, the Intelligent Transportation Systems Joint Program Office (ITS JPO) sponsored research by a team of researchers at the Volpe Center.

The goal of this research was also to identify emerging issues related to automation and provide background to U.S. DOT staff and state and local officials potentially considering hosting pilot activities in their communities. Automated delivery vehicle and device concepts vary in size (from smaller sidewalk delivery robots to light- and medium-duty road vehicles), operating speed, delivery phase (middle-mile, last-mile, or final-50-feet), and service model.

In December 2020, Volpe and ITS JPO released [“Emerging Automated Urban Freight Delivery Concepts: State of the Practice Scan.”](#) a report based on research conducted through literature reviews, test and concept monitoring, and stakeholder engagement. Key findings of the report show there is broad interest in automation technologies, though vehicle and device designs are still evolving, final service models have yet to be determined, and state and local governments are in the early stages of policy development. The research also found that teleoperation capabilities would be necessary for certain concepts.

These findings were presented at the 2020 Transportation Research Board (TRB) Virtual Forum on Sustainability and Emerging Transportation Technology, the TRB 2021 Annual Meeting, the 2021 AAMVA Virtual Workshop and Law Institute, and the 2021 TRB Automated Road Transportation Symposium (ARTS 2021). Following publication of the report, the Volpe team worked with ITS JPO to identify topics of interest related to automated delivery concepts and developed technical memoranda on those topics. Volpe has also assisted with knowledge transfer at other meetings, including TRB/Unmanned Vehicle Systems International (AUVSI) 2020 Automated Vehicle Symposium (AVS 2020). At AVS 2020 and ARTS 2021, Volpe and ITS JPO

planned and hosted breakout sessions on automated delivery vehicles and devices.

If deployed and scaled, automation technology itself will have far-reaching impacts on the transportation system. The Volpe Center’s research will also help improve stakeholders’ understanding of the state of the technology and its development, testing, and commercialization. **Sponsor: ITS JPO**

RAIL

Using the Geographic Information System to Help FRA Visualize and Analyze the U.S. Railroad Industry

The Federal Railroad Administration (FRA) developed and maintains the North American Rail Network (NARN), which is the federal government’s official GIS-based digital representation of the U.S. rail network.¹⁷ When used in conjunction with other GIS datasets, transportation analysts can view and analyze numerous facets of rail systems, such as the owners/managers of rail sections, the number of crashes that have occurred on sections of rail, the demographics of neighborhoods that rail passes through, and the number of people and commodity types that move over rail.

The FRA also collects extensive data on grade crossing accidents and other rail-related incidents in order to track accidents that exceed a certain dollar threshold or result in injuries or fatalities. Additionally, the Surface Transportation Board (STB) produces the annual Carload Waybill Sample for all rail carriers terminating 4,500 or more revenue carloads annually. When GIS layers are created from accident/incident data and STB Carload Waybill Sample data and combined with NARN and other geospatial data (e.g., inspector

¹⁷ North American Rail Lines – National Geospatial Data Asset (NGDA); <https://www.geoplatform.gov/metadata/faf7f37c-e078-57e8-a950-70dadb659533>.

regions, U.S. Census data), GIS can be used to visualize, analyze, and gain insight into the U.S. rail system in ways not otherwise possible.

The Volpe Center's GIS team works closely with the FRA Office of Railroad Policy and Development's GIS Program to maintain, map, and spatially analyze rail lines, operations, and accident/incident data so that FRA can take full advantage of the unique insight and power that GIS has to offer.

Over the past several years, the Volpe Center has worked with FRA to modernize the process for using the STB Carload Waybill Sample data with NARN. These efforts have provided valuable insight into commodities movement based on tracking products shipped by rail. Over the past year, the Volpe Center greatly improved reporting, diagnostics, and interactive data exploration to help FRA better understand the Carload Waybill Sample data and address any issues that might result in dropping records. Volpe Center contributions to this program over the past year have also included:

- Automated the process of turning highway-rail grade crossing accident/incident report data, and rail equipment accident/incident data into GIS layers. The automation of this complex process resulted in up-to-date and consistently generated GIS-based accident/incident layers which allows the FRA to quickly visualize, query, and analyze the latest reported accidents and incidents.
- Developed a process to estimate trains per day on the U.S. portion of the NARN from individual trains per day estimates contained in FRA's Highway-Rail Crossing Inventory. Knowing average annual daily traffic is important for analyzing highways, and having trains per day estimates on the NARN is important for performing a wide variety of analyses.
- Reviewed all commuter rail systems and made updates to the NARN to ensure it accurately depicts all commuter rail lines and stations.

By bringing together accurate, up-to-date, GIS-based information on railroad lines, operations, and accidents, FRA is able to use the power and capabilities of GIS

to better understand trends, find hot spots (e.g., grade crossing accidents), target inspections, and ultimately make better-informed, data-driven decisions.

Sponsor: FRA

AVIATION

Exploring Space-Based Automatic Dependent Surveillance-Broadcast Technology

Space-Based ADS-B (SBA), a new technology, uses satellites, instead of ground stations, to receive aircraft ADS-B broadcast position information. Since SBA satellites are in a Low Earth Orbit constellation, they cover all the earth's airspace all the way to the ground in most locations. FAA is exploring SBA for use in air traffic control (ATC), air traffic management (ATM), and analysis functions. As part of this exploration, the Surveillance and Broadcast Services (SBS) Advanced Surveillance Enhanced Procedural Separation (ASEPS) Program conducted an initial examination of the SBA data's value to FAA.

Through the ASEPS Program, the FAA purchased non-operational SBA data from Aireon for an initial one-year evaluation from September 1, 2020, through August 31, 2021. The SBA data purchase was later extended through January 2022. The Volpe Center led this evaluation, supporting FAA from inception. The term "non-operational" data denotes that the SBA data was not used in any operational settings. While not evaluated during actual operations, the non-operational data was employed to evaluate potential operational uses, such as obtaining improved estimated times of arrival for oceanic arrivals and as backup for certain terrestrial surveillance outages. The non-operational data was also evaluated for improving data analysis, such as accident investigations and safety risk assessments.

Evaluation of SBA data is an FAA priority, and there is significant external interest. The goals of this initial

evaluation of SBA data were to: (a) Advance FAA understanding of SBA data; (b) Identify use cases that will benefit the FAA and NAS users; (c) Ensure ROI; and (d) Show value across FAA and use in investment planning. To meet these goals, the SBS ASEPS Program Office solicited potential SBA data users from across the FAA, familiarized the SBA users about the data, supported their evaluation of the data, and assessed benefits that arose from the use cases.

This initial one-year SBA data evaluation has provided the FAA with information for further steps in proceeding with SBA data. The evaluation has met its goals by providing an understanding of SBA data's strengths and limitations, its uses across the FAA (20 FAA organizations participated with 16 organizations finding benefits), and a rough order of magnitude estimate of its value to FAA and NAS users. The Program Office will continue to assess new findings about the SBA data, develop implementation plans for beneficial use cases, and mature procurement strategies. **Sponsor: FAA**

MULTIMODAL

Volpe Delivers Final Report on U.S. DOT's Complementary PNT Technology Demonstration and Briefs National Space-Based Executive Committee

Accurate sources of Positioning, Navigation, and Timing (PNT) information support critical infrastructure, including the transportation sector, and are essential for national and economic security. The primary and most recognizable service that supports infrastructure is GPS. However, since GPS relies on signals broadcast from a constellation of satellites located more than 12,000 miles from earth, its signals are very low

received power and are vulnerable to intentional and unintentional interference. The National Defense Authorization Act for Fiscal Year 2018 (Section 1606 of Public Law Number 115-91) directed the U.S. DOT, U.S. DoD, and the Department of Homeland Security (DHS) to conduct a complementary PNT and GPS backup capability demonstration.

The Volpe Center supported the joint effort between OST-R and the U.S. Space Force's Space and Missile Systems Center in a partnership to plan and execute the demonstration. This involved substantial coordination of three demonstration sites, including setup of vendor equipment and installation of a government reference system to confirm vendor technologies' performance. These efforts culminated in a demonstration report that indicates there are suitable, mature, and commercially available technologies that can complement PNT services provided by GPS in the event that GPS is denied, degraded, or manipulated.

In 2019, the Volpe Center developed and executed a rapid acquisition strategy to meet the demonstration schedule. Volpe awarded contracts to 11 vendors to support the demonstration and coordinated their participation.

In March 2020, a Volpe team conducted multiple demonstrations of the vendors' technologies at the Volpe Center's Aviation Weather Research Facility at Joint Base Cape Cod (JBCC) and the NASA Langley Research Center (LaRC) to collect data under a variety of scenarios. These scenarios provided vendors with a combination of use cases for static and dynamic positioning using two vans and multiple unmanned aerial systems (UAS) along with precision timing capabilities in the absence of GPS. The vendors were able to self-select their participation in nine available scenarios they believed would best demonstrate their technology. Vendor user equipment (UE) PNT outputs were collected by the Volpe data collection and reference system.

In May 2020, positioning and/or timing scenarios were analyzed to provide 14 measures of effectiveness (MoEs), structured as rubrics. Volpe SMEs employed

the MoE rubrics to assess the strengths of a given technology as demonstrated under a given scenario. The results of the MoE assessment were then collated into an information framework. The framework conveys information in a convenient format and provides weighted scoring functions for needs and/or requirements. Decision-makers can effectively apply these weightings against the 14 MoEs to evaluate candidate technologies suitable for their local situations.

In August 2020, the Volpe team briefed the National Space-Based PNT Executive Committee (EXCOM) about the candidate technologies and communicated two DOT recommendations:

1. DOT should develop system requirements for PNT functions that support safety-critical services.
2. DOT should develop standards, test procedures, and monitoring capabilities to ensure PNT services, and the equipment that utilizes them, to meet the necessary levels of safety and resilience identified in the first recommendation.

In September 2020, the Volpe Center provided its draft final report to U.S. DOT who coordinated it for release to Congress in January 2021. **Sponsor: OST-R/DoD**

Innovative Uses of Data Science to Solve Transportation Problems

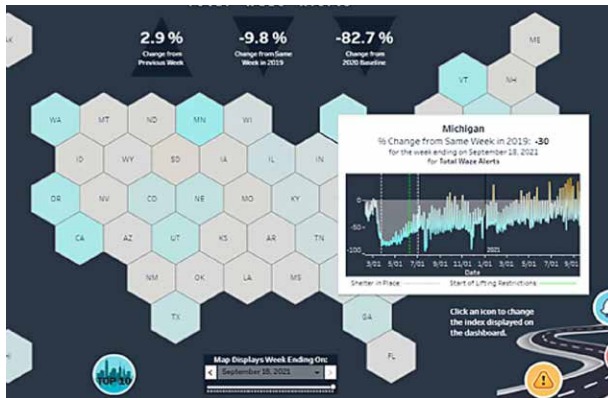
State DOTs, MPOs, and regional transportation planning agencies rely on complex data to solve the nation's congestion, infrastructure, and equity issues. Volpe Center data experts are using tools from the data science and machine learning toolbox to identify roadway safety issues and address old transportation problems in new ways. Using big data and computer vision solutions to provide state DOTs with new sources of roadway infrastructure data and natural language processing (NLP), the Volpe Center is creating new methods of ingesting and processing data from multiple sources.

Efforts to reduce traffic congestion and identify safety concerns are often hampered by a lack of relevant data. Volpe researchers leveraged a nationwide archive of user-reported traffic alerts provided by a DOT archive of Waze traffic information to understand congestion patterns and inform transportation planning studies at the Adirondack Park and Mount Rainier National Parks. The data archive provided Volpe researchers with insights into congestion “hot spots” and crash trends. Adirondack High Peaks Region used Waze analytical data to identify key time periods when shuttle service might alleviate traffic congestion, which are detailed in the New York State Adirondack High Peaks Region Shuttle Feasibility Study (bts.gov). The Volpe Center is currently working with the National Park Service using Waze data to identify safety risks and crash trends in national parks within the NPS Interior Regions 6, 7, and 8.

The Volpe Center is also collaborating with the University of North Carolina Renaissance Computing Institute (RENCI) and the North Carolina Department of Transportation (NCDOT) to develop an artificial intelligence (AI) computer vision tool for automated analysis, extraction, and annotation of roadside features on rural roads from existing video data. This information will be used to develop a prototype predictive tool to determine a safety rating for rural road segments. The tool will help to facilitate safety initiatives more efficiently and effectively on North Carolina's rural roadway system. AI components will also provide a blueprint for other jurisdictions and states.

Volpe developed a COVID-19 Waze Traffic Alert Dashboard in March 2020 to track relative changes in weekly traffic jam alerts for all U.S. metropolitan areas. The team has continued to provide weekly updates through 2021. The Waze dashboard provides a rapid indicator of traffic jams covering all U.S. metropolitan areas, increasing accessibility to state, metropolitan, and county-level time trends. This ongoing project aims to enhance the dashboards for broader use by U.S. DOT.

Text data is a large untapped resource for the U.S. DOT. Volpe data scientists worked with OST-R to build a toolbox of NLP approaches to make tasks like



National-level dashboard of Waze traffic alert frequency.
Source: U.S. DOT Volpe Center

summarization, comparison, and exploration of text data easier for U.S. DOT offices. For example, OST-R asked Volpe to develop tools to identify points of similarity for all departmental-funded research projects, which was not possible to do manually. Volpe experts used open source similarity techniques, tuned for the kind of text used across U.S. DOT, and created a dashboard for OST-R staff to quickly find previously unknown complementarity for research projects across the Department. Volpe data scientists continue to build on this concept as the project develops.

Historically disadvantaged populations continue to suffer from systemic inequities. Gaps exist in available knowledge and tools that hinder the ability of transportation agencies to integrate social equity considerations into transportation programs, policies, projects, and other activities. A Volpe team developed a prototype Transportation for Social Equity (TransportSE) tool to work toward closing those gaps. The tool can improve the ability of transportation agencies at all levels to understand, visualize, and analyze transportation equity indicators (including benefits, such as access to transportation services, and burdens, such as noise and pollution) in relation to social equity variables such as race and income.

The approaches highlighted here demonstrate Volpe's capabilities to use data science innovations for transportation planning, operations, safety analysis, and to improve business processes. Further expansion of

these capabilities will help Volpe meet the requirements of increasing volumes and complexity of data, as well as the need for advanced analytics in all areas of transportation. **Sponsors: NPS, OST-P, OST-R, BTS, New York State Department of Environmental Conservation (NYSDEC)**

Gettysburg National Military Park and Eisenhower National Historic Site Multimodal Transportation Study

Improving visitor access and experience at Gettysburg National Military Park (GETT) and Eisenhower National Historic Site (EISE) has been an enduring goal for the NPS. At GETT, which has over 1 million visitors per year, visitor access is primarily by automobile and there is significant congestion and a lack of parking at highly visited areas. Other modes, such as buses, bicyclists, pedestrians, and equestrians further exacerbate congestion and safety issues across GETT. These transportation issues impact GETT's landscape and interpretive value, intended to honor and commemorate the Battle of Gettysburg where more soldiers died than in any other battle fought in North America before or since. At neighboring EISE, visitation has been declining over the last 20 years possibly due to limited public access and perceived inconvenience of the shuttle system. Alternative transportation options to access EISE—including connections to public transit and bicycle/pedestrian trails—are also limited.

Although there have been several previous studies examining the transportation-related challenges and potential solutions for both GETT and EISE, the NPS has not undertaken a comprehensive analysis of the complex set of issues across both parks. To build on this past research, and holistically examine this high-priority planning need, NPS requested Volpe's technical assistance to adapt a planning approach the NPS has used for unit management planning projects to the transportation context. As such, Volpe supported the NPS to develop a new preliminary transportation



Gettysburg National Military Park Visitor Center. Source: Gettysburg Foundation. Source: National Park Service

planning (PTP) process, and applied it to GETT-EISE as a pilot. The GETT-EISE PTP not only completed a useful plan for GETT-EISE, but also developed a PTP process that will be used throughout NPS to help park units prioritize their transportation issues, incorporate input from critical stakeholders, and develop action-oriented plans with specific milestones, which will lead to the changes they agree are important to the park unit.

For the GETT-EISE PTP, Volpe facilitated a stakeholder engagement process that informed NPS's understanding of key issues, and helped NPS integrate its needs and priorities into the statewide and metropolitan transportation planning and programming processes. For example, during the PTP, Volpe facilitated discussions among NPS, FHWA, Pennsylvania DOT, Adams County Transportation Planning Organization (ACTPO), Rabbitransit, and others to identify partnership funding opportunities. Through this stakeholder engagement, Volpe identified specific partnership opportunities to improve transportation issues at GETT-EISE, such as those related to safety, congestion, transit and trails connectivity, and equitable transportation access. These partnership strategies were incorporated into the PTP implementation plan as well as into partner plans and programs.

The final product of the GETT-EISE PTP is a five-year implementation plan. Volpe facilitated development of

the implementation plan among NPS unit-, regional-, and Washington Office-level staff. To advance the five-year implementation plan, Volpe worked with NPS to identify funding and initiate the immediate next steps. NPS project partners and leadership have regularly commended the project team and PTP process, stating that the PTP will help GETT-EISE address its complex transportation issues while also establishing a process for others to do the same. **Sponsor: NPS**

Advanced Acoustic Modeling of Urban Air Mobility Concept Vehicles

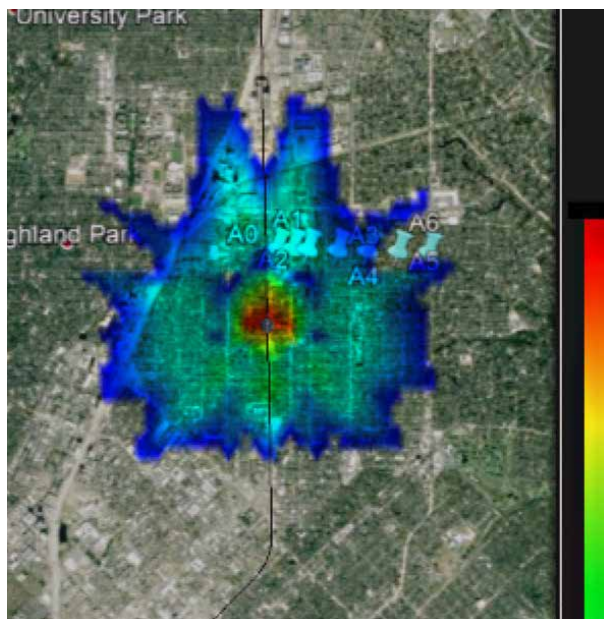
The U.S. transportation network will look dramatically different in the coming years as advanced air mobility vehicles are introduced that will change the way people travel within and between metropolitan areas. To prepare for this innovative future, transportation experts are researching the potential noise impacts of these vehicles on communities and urban populations.

In spring 2020, NASA transferred the Advanced Acoustic Model (AAM) to the Volpe Center to

improve and expand the modeling tool. AAM software allows users to model vehicle sound generated by helicopters, tiltrotor vehicles, and fixed-wing aircraft using site-specific receivers. In partnership with NASA, Volpe experts conducted an acoustic analysis of a NASA Urban Air Mobility (UAM) concept vehicle to demonstrate modeling tool interoperability. Volpe staff conducted a comparative analysis with other existing tools and demonstrated the importance that source noise directivity and propagation modeling fidelity have on predicted results. The Volpe Center hopes to expand the use of AAM and increase its customer base to other areas, including the future urban air mobility arena.

Since AAM v3.0's release in December 2020, the suite of software tools has been provided to more than 75 entities and individuals worldwide, representing the aerospace and transportation industry, the U.S., and international government agencies and academic institutions. AAM provides a high-fidelity mechanism for air vehicle designers to project community sounds;

This figure is a screen shot from an acoustic animation that allows the vehicle designer and operations planner to “see” the noise being emitted into the community. The tool also allows designers to take into account local time varying background noise levels to assess loudness metrics at particular points of interest and understand the specific acoustic spectral emission directivity. Source: Steve Rizzi, Juliet Page, and Rui Cheng



assess impacts of future vertiport and skyport plans; and for researchers to evaluate advanced metrics beyond those currently supporting regulatory or NEPA actions.

Beta versions of the AAM software version 3.1 were released in May 2021 and July 2021. These beta versions offer additional enhancements to analyze higher fidelity noise defined in terms of narrow band acoustics from UAM vehicles. The Air Force Civil Engineering Center (AFCEC) in San Antonio, Texas supports distribution of AAM software via the Volpe Center website, as it is an integral part of the noise analysis of military aircraft for NEPA. A paper titled [“Comparison of Two Community Noise Models Applied to a NASA Urban Air Mobility Concept Vehicle”](#) was published jointly by NASA and the Volpe Center at Inter-Noise in August 2021, which assessed modeling applicability, capabilities, and limitations. The paper also identified potential future modeling improvements.

The Volpe team completed the bulk of this innovative project in 2021, but additional sponsor funding will allow for continued analysis and AAM model development for UAM. **Sponsor: Volpe with collaboration from NASA**

Looking to New Innovations and Improving New Methods with the Volpe Innovation Accelerator

To further its climate of innovation and spur innovation beyond everyday work, the Volpe Center launched the Volpe Innovation Accelerator (VIA). VIA aims to harness the creative energy of Volpe’s technical staff by encouraging collaboration and building on existing skillsets and current work to accelerate ideas and solve transportation challenges, especially those aligned with U.S. DOT priorities. A Volpe team led the launch of VIA, designed the logo and brand, developed the series sprint events, designed a system for virtual collaboration, organized and hosted the events, and managed project evaluations.



The Truck-Parking-Using-Drones VIA team explored the use of an autonomous drone equipped with machine learning and AI to inform truckers of available parking and reduce dangerous parking on ramps. Source: U.S. DOT Volpe Center

Throughout the year, VIA sponsored a series of successful innovation sprints:

Sprint 1 resulted in the creation of eight concept teams, each of which developed a prototype or concept paper. Three illustrations of promising concepts include:

- **UAM and Total Mobility Innovation:** FAA and NASA envision highly autonomous short-haul and light passenger aircraft (UAM vehicles) will be an important component of the nation's transportation future. NASA has plans for hundreds of such vehicles in various cities by 2035. Volpe experts developed a software tool to help cities prepare for the arrival

of UAM technology and vehicles, as well as guide potential business development opportunities.

- **Machine Learning Algorithm to Process Eye Tracking Data:** Tracking the eye movement of drivers during simulator training can be a challenging and time-consuming task. A Volpe team developed an algorithm to identify when driving study participants look at single or multiple locations while operating a vehicle. This tool could significantly reduce labor costs, improve R&D approaches, and provide benefits to other agencies who may sponsor future work with the Volpe Center.
- **Non-Traditional Traffic Safety Intervention Research:** A number of Volpe Center sponsors, state DOTs, and local partners are keenly interested in effective traffic safety enforcement practices. New technologies exist within the transportation industry that could vastly improve safety, but the necessary research has not been conducted. A Volpe team performed a literature review of innovative technologies and non-traditional traffic safety strategies and provided a high-level summary of findings that could be of interest to current and future sponsors. This effort fills a potential lost opportunity for improving safety and reducing societal costs, and highlights the potential equity impacts across communities.

In June 2021, VIA announced the following Sprint 2 projects selected to receive additional seed funding:



- Using Virtual Reality to Study Vehicle Operational Safety Near Vulnerable Road Users
- Truck Parking Status Using Drones
- Inclusive Demographic Data Collection Handbook
- Creating a Climate Change Toolkit for the Volpe Center
- Environmental Justice Impact Lifecycle

VIA kicked off in August 2020 and plans are underway for a third sprint in spring 2022. On top of encouraging innovation and collaboration among staff, the VIA launch has heightened employee engagement and improved satisfaction, which should lead to improved retention and productivity. VIA encourages and provides an opportunity for staff to get out of their comfort zone while supporting Volpe's mission to advance transportation innovation for the public good.

Sponsor: U.S. DOT Volpe Center

A photograph of an airport tarmac. In the foreground, the nose and cockpit of a white airplane are visible. Behind it, various ground support equipment (GSE) like baggage carts and service vehicles are parked. In the background, the airport terminal building is visible under a clear sky. A semi-transparent green overlay covers the middle portion of the image, where the main text is placed.

ECONOMIC STRENGTH AND GLOBAL COMPETITIVENESS

Source: Adobe Stock



With its broad range of multimodal, multidisciplinary expertise from engineering to economic analysis, the Volpe Center works across modes and federal agencies to support critical transportation modernization programs and initiatives focused on growing an inclusive and sustainable economy.

AVIATION

Impact of COVID-19 on the Aviation Industry

The ongoing pandemic has significantly impacted the way and extent to which people are traveling, and the long-term effects of COVID-19 on the transportation sector are not fully known. NASA's Aeronautics Research Mission Directorate asked the Volpe Center to undertake a COVID-19 impact study to research the pandemic's effects on various modes of transport and identify actual mitigations to alleviate potential future shocks and provide resiliency.

The study, which began in early 2021, had the primary goal of understanding the effects of the pandemic on the domestic passenger and freight aviation industry in the context of the pandemic's effects on other transportation modes. The intent of the study was to

provide initial insights into possible shock mitigation and resiliency strategies for aviation's recovery through comparison with other transportation modes.

Volpe formed a multidisciplinary team from four divisions across three centers to support the project and provide subject matter expertise. The intent of this work was to provide initial insights into transportation modes that may be leading or lagging indicators of aviation's recovery and identify possible transportation shock mitigation and resiliency strategies. Volpe team members and subject matter experts researched technologies and policies that may prevent or reduce the initial aviation passenger/cargo drop in the case of a future pandemic or other, similar scenarios, and potential solutions that may shorten the recovery response time or increase the rate of passenger/cargo recovery.

The analysis showed an unprecedented affect from the pandemic on modal passenger activity, which fell to historic lows in early 2020. Freight activity fared significantly better than other modes, while domestic air freight actually increased during the pandemic due to its ability to fill supply chain gaps. Much of the transportation sector's resiliency seems to have been influenced by government policy and action. Overall, there was a high degree of uncertainty regarding modal recovery as the pandemic is ongoing and many modes remain well below pre-pandemic levels.

The Volpe team concluded the bulk of its research and documentation work in September 2021. **Sponsor: NASA Aeronautics Research Mission Directorate**

Reducing Congestion at U.S. Airports with the Terminal Flight Data Manager

As commercial air traffic experiences a steep climb worldwide, congestion at U.S. airports will continue to increase over the coming year. FAA reports that at 30 major U.S. airports, delays of over 15 minutes increased 15 percent from 2015 to 2019, affecting some 300,000 flights.¹⁸ When planes depart the gate only to spend extended time in queue for takeoff, the expended fuel increases emissions and contributes to climate change. It is essential for FAA to collaborate with stakeholders to efficiently plan and direct air traffic on the ground throughout the NAS.

Terminal Flight Data Manager (TFDM) is a critical part of the Next Generation Air Transportation System (NextGen). TFDM represents a transformative change in surface operations across the NAS, and will have a nationwide impact when implemented, with full capabilities at 27 airports throughout the country and improved data exchange at a total of 89 facilities.

TFDM streamlines the flow of departures on the airport surface by improving collaboration and decision-making capabilities between airport gates and air traffic controllers. Every delayed flight is an opportunity for TFDM's surface-metering capability to reduce fuel burn by keeping aircraft at the gate. A 2016 analysis estimated that over its lifetime (2016-2048) at the full-capability of 27 airports, TFDM would result in 313 million gallons of fuel savings, and an associated CO₂ reduction of 3.0 million metric tons, due to 1.3 million hours of reduced taxi time.¹⁹

The Volpe Center supports TFDM implementation throughout the NAS by providing expertise to the TFDM Collaborative Site Implementation Team (CSIT). CSIT performs outreach to airlines and other flight operators, airport operators, ramp controllers, and

other participants in NAS operations. CSIT works to explain the changes FAA will be making in the NAS as the result of TFDM implementation, and to engage stakeholders for feedback to improve collaborative decision making for surface operations.

The Volpe Center supports CSIT training and outreach about implementation timelines and other details, and provides documentation for the new electronic data-exchange services that enable TFDM. Volpe completed the first public release of the Data Operational User Guide (DOUG), which was published on FAA's Collaborative Decision Making website on February 19, 2021. Stakeholders are oriented to the information exchange process, and to the data types that TFDM publishes, so they can assess which elements are most important to their operations. Volpe is currently updating the DOUG to incorporate information about changes being made to other System Wide Information Management services that support TFDM operation.

Volpe Center staff also produced a draft Surface Metering Performance Report (SMPR) in late July 2020 and collaborated with stakeholders to collect feedback in two industry focus groups on August 11, 2020 and August 20, 2020. Volpe discussed stakeholder feedback with the FAA and finalized the draft in early October 2020. Surface metering is a collaborative process, involving input from, and feedback to, multiple airport staff and personnel. Both FAA and partner organizations benefit when they review the effects of surface metering to evaluate whether operational changes are appropriate to improve efficiency. The draft report presents users with a combination of pre-existing TFDM metrics and new, Volpe-developed metrics and summary statistics, in a clear, understandable way. The Volpe Center's expert knowledge of TFDM data feeds enabled it to generate extensive charts and summary statistics as part of the SMPR. This report provided FAA with feedback on which information is most important to stakeholders for TFDM metrics once the TFDM system goes live. The TFDM implementation timeline has been affected by COVID-19; the most recent update is that initial deployment for the improved data exchange capability at Phoenix Sky Harbor International Airport will be

¹⁸ Air Traffic By the Numbers; https://www.faa.gov/air_traffic/by_the_numbers/media/Air_Traffic_by_the_Numbers_2020.pdf.

¹⁹ Terminal Flight Data Manager (TFDM) Environmental Benefits Assessment, Project Report ATC-420, Tom G. Reynolds, MIT Lincoln Laboratory, November 10, 2016.

Better Data Exchange May Reduce CO₂ Emissions

TERMINAL FLIGHT DATA MANAGER (TFDM) ALLOWS PLANES TO WAIT AT THE GATE

During fiscal year 2019, flight delays **rose by 15 percent**, to almost

300,000 flights

with reportable (greater than 15 minutes) departure delays.

TFDM is the surface management solution for the FAA's Next Generation Air Transportation System (NextGen).

Every delayed flight is an opportunity for TFDM surface metering capability to potentially **reduce fuel burn** by keeping aircraft at the gate where **they don't need to keep engines running** to provide power.

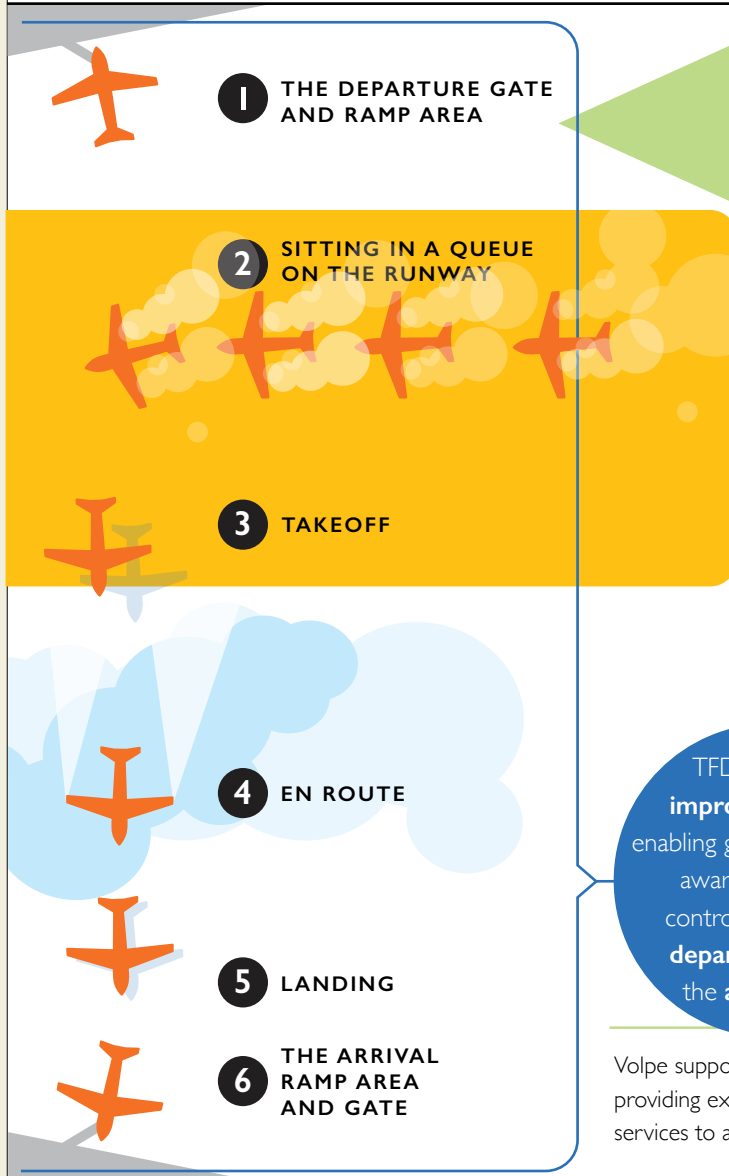
Surface metering reduces the time aircraft spend waiting on the tarmac ...

... and keeps that waiting time at the gate.

If airlines know a flight will be held at the gate for an hour, passenger boarding can be delayed so that people can wait in the more comfortable airport, rather than in their seats.

TFDM will also **improve safety** by enabling greater situational awareness by the controllers from the **departure gate** to the **arrival gate**.

Volpe supports FAA in TFDM implementation by providing expertise on the new TFDM data exchange services to airports, airlines, and other stakeholders.



in May 2022, with initial availability of the full suite of TFDM capabilities, including surface metering, projected for May 2023.²⁰ A new TFDM deployment waterfall was published by FAA in fall 2021. **Sponsor: FAA Terminal Flight Data Manager) Collaborative Site Implementation Team, part of the CDM (Collaborative Decision Making)/International Operations Group, AJR-13**

HIGHWAYS

Linking Transportation Investment Decisions to Performance Management and Targets

MAP-21 ushered in a new era of transportation with an increased focus on managing the performance of transportation networks over time, yielding more risk-based decision making and investments by recipients of federal funds. FHWA subsequently implemented 17 performance measures for which state DOTs must set targets and report back on performance on an annual or bi-annual basis. Working together, FHWA, state DOTs, and stakeholders are putting the performance data to use, improving transparency and accountability, and growing their performance management capabilities.

This performance data provides FHWA's Transportation Performance Management (TPM) Team with over 500 critical data points annually, in the areas of Safety, Infrastructure Condition, and System Performance.

The Volpe Center supported FHWA's TPM Team by analyzing each state's performance against their respective targets and also the state's own self-assessment on the extent to which their investment decisions were guided by previously established targets.

20 SWIFT: FAA Industry Collaboration Workshop #14, May 27th 2021. Presentation available at https://www.faa.gov/air_traffic/technology/swim/swift/media/SWIFT%20Meeting%20Presentation%2014%205.27.21.pdf.

The Volpe Center team's analysis showcases how states are performing relative to their targets, and highlights trends in target setting data across states for each of the 17 performance measures. The analysis concluded that states are indeed evolving their investment strategies to adapt to these new requirements in a manner that is complete, accountable, and consistent. However, more work is needed to continue to shift the paradigm toward ongoing performance management as a necessary key driver of investment decision making.

The Volpe Center supported this project throughout the first four-year period, spanning 2018-2021, and delivered two bi-annual TPM Data Reports and multiple versions of TPM State Profiles showcasing each state's results. Volpe staff's knowledge and expertise in data analysis, GIS, and graphic design aided this project.

Volpe also assisted FHWA in establishing clear baselines against which future performance can be measured, resulting in safety benefits, encouraging transformative infrastructure, and fostering economic growth. **Sponsor: FHWA Office of Transportation Performance Management**

RAIL

Expediting Environmental Compliance for Major FRA Programs and Projects

Compliance with federal environmental laws and regulations is a requirement for advancing critical infrastructure projects that receive federal funding. This process presents many challenges for federal agencies as the required documentation can be extensive and highly technical. Obtaining project approval in a timely and efficient manner depends on the skilled navigation of review processes and federal environmental laws.

In 2021, over 100 FRA passenger and freight rail projects underwent environmental review in accordance with NEPA, Section 106 of the National Historic Preservation Act, the Endangered Species Act,

and related federal laws, orders, and regulations. With the Volpe Center's comprehensive technical expertise, environmental compliance for a significant portion of the FRA's rail infrastructure and service projects were completed, allowing the projects to advance to the design, engineering, and construction phases.

To meet the demands of this assignment, Volpe assembled an eight-person core team with environmental analysis and management capabilities, supplemented by Volpe professionals with expertise in cultural resources, noise, air quality, climate change, policy, and rail planning. The Volpe team provided a federal presence on behalf of FRA, coordinating with key stakeholders, grantees, project sponsors, and other agencies to expedite the review processes. The team implemented known best practices in environmental review, expediting activities to advance efficiencies and maintain aggressive project schedules. This was essential for time-sensitive projects to move forward.

Volpe's NEPA specialists and subject matter experts provided critical procedural and technical knowledge. The Volpe team provided guidance on needed studies and performed technical reviews, ensuring that methodologies and analyses specific to the environmental resource areas being reviewed were appropriate. As a result, the documentation and

analyses for each review were complete, accurate, and relevant.

This work took place across the country and involved a number of railroads and communities in 15 states. The Volpe team identified any policy-related issues or outstanding items that required further discussion and facilitated their resolution with the FRA. Overall, Volpe's success in advancing the environmental review of FRA's pending projects made a significant contribution to advancing project development for infrastructure and service projects resulting in the increase of the national benefits of passenger and freight rail. **Sponsor: FRA**

Modernizing the U.S. Department of Defense Rail Fleet

The U.S. Department of Defense (DoD) rail fleet contains more than 120 locomotives with an average life span of 50 years. An aging rail fleet leads to

Ultra-low emitting locomotive operating at U.S. Army Fort Hood, Texas. Source: U.S. DOT Volpe Center



increased toxic emissions and poor operational readiness due to maintenance costs and the need to replace parts for older trains. This fleet is in critical need of new, modern equipment to increase the efficiency, reliability, and safety of rail operations on U.S. Army installations and U.S. Navy facilities, and to reduce carbon emissions. The Volpe Center is assisting DoD in modernizing locomotives and rail equipment that are critical to the mission of the U.S. Army and U.S. Navy as part of the Rail Modernization Program.

Since 1989, the Volpe Center has applied its engineering expertise to help DoD modernize their rail fleet. To date, the program has replaced approximately one third of the Army's non-regulated locomotives with EPA tier compliant ultra-low emitting locomotives. This has reduced harmful emissions by more than 86 percent. By using EPA calculations for the units replaced, the DoD lowered estimated locomotive emission rates by EPA Tier level starting in 2008.

In May 2021, the Volpe Center successfully replaced two non-regulated locomotives that were manufactured in the 1950s with rail car mover technology exceeding U.S. EPA emissions tier requirements. These new locomotives enhance operations safety while reducing the dependency on fossil fuels and are less harmful to the environment.

The introduction of ultra-low emitting locomotives offers quieter and higher efficient operations, leading to less demand for fossil fuels, reduced harmful emissions, and safer operations. This higher efficient locomotive fleet is capable of reducing over 500 tons of NOx per year. If all DoD locomotives are replaced with similar new technology, this would increase the capability to reduce more than 2,000 tons of NOx per year.

The Volpe Center continues to support DoD's U.S. Army Tank-Automotive and Armaments Command and U.S. Navy Facilities Engineering and Expeditionary Warfare Center in modernizing the rail fleet to lower locomotive emissions and help decrease the dependency on fossil fuels. **Sponsor: U.S. Army**

PUBLIC TRANSIT

Studying Advanced Data Science Methods to Improve Transit Systems

The field of data science has grown significantly in recent years, driven by expanding availability of big data, increasingly accessible and affordable computing and storage resources, and resulting developments in machine learning and deep learning. Observing that transit is a data-rich and data-driven field, FTA asked the Volpe Center to study the current use of emerging data science methods and tools by transit agencies and identify priority use cases and key adoption considerations for agencies that are looking to expand their use of these methods.

The goal of this project is to identify opportunities for transit agencies to expand their use of emerging data science to enhance service, performance, and competitiveness of transit. To this end, Volpe staff conducted literature reviews in multiple areas and held interviews with subject matter experts from a representative set of transit agencies. The Volpe Center will synthesize the findings from this research in a state-of-the-practice report, which is expected to be published by the end of 2021.

This report will identify opportunities to leverage data and emerging analysis capabilities to effectively and efficiently improve the performance of transit. It is also expected to help transit agencies make more informed decisions about investing limited resources in enhancing their data capabilities. Investigating advanced data science methods and helping transit agencies expand their use of them furthers the U.S. DOT's transformative infrastructure goal. **Sponsor: FTA, Office of Research, Demonstration, and Innovation**



TRANSPORTATION EQUITY

Source: Adobe Stock



The U.S. DOT is committed to advancing equity, civil rights, racial justice, environmental justice, and equal opportunity. The Volpe Center has been working to support programs to reduce inequities and promote safe, affordable, accessible, and multimodal access to opportunities and services.

RAIL

Increasing Access to Rail Stations for Travelers with Disabilities

The Americans with Disabilities Act of 1990 (ADA) requires that stations in the intercity rail transportation system be made readily accessible to and usable by individuals with disabilities. Amtrak's network of 526 stations over 46 states—in addition to the District of Columbia and three Canadian provinces—plays an important role in the national transportation network by providing travelers with a safe, efficient, and reliable alternative to highway and airline travel. In 2009, Amtrak initiated the ADA Stations Program to make its stations ADA compliant and accessible.

In coordination with FRA, Amtrak developed a list of ADA priorities and work required to bring stations with accessibility deficiencies into compliance. The overall strategy is to advance station accommodations through the survey, assessment, design, and construction phases. Where Amtrak has responsibility, they perform an assessment to identify the specific ADA deficiencies, then design and implement appropriate remediation measures.

From 2009 to the end of FY 2018, changes made through the program included: the installation of 192 station-based mobile lifts, new level boarding platforms with compliant detectable warnings at two stations, new detectable warnings on existing platforms with compliant detectable warnings at an additional 38 stations, accessible parking improvements at 132 stations, accessible restroom improvements at 49 stations, accessible station signage at 206 stations, Passenger Information Display Systems at 32 stations, and numerous other upgrades and improvements.

Stations where Amtrak has legal responsibility will be ADA compliant upon program completion. Through the end of April 2021, 76 stations have been made fully compliant for all the elements Amtrak is responsible for and another 71 stations are complete for all elements except the platform.

The Volpe Center has supported the FRA's ADA Stations Program by conducting design reviews of the completed construction plans and conducting site



Updated accessible walkway at Rocklin, CA. Source: U.S. DOT Volpe Center

assessments at completed Amtrak stations. These assessments provide FRA with a valuable resource to certify that all the work completed at Amtrak stations will meet ADA requirements. By progressing toward the removal of ADA barriers and making each station accessible, FRA and Amtrak are ensuring everyone will be able to access these public resources. **Sponsor: FRA**

HIGHWAY

Performance Evaluation of Dispersion Models for Estimating Near-Road Air Quality

Accurately estimating near-road air quality is important for regulatory compliance with National Ambient Air Quality Standards, which are in place to protect public health and the environment. Dispersion models that overestimate pollution concentrations can place

an undue burden on project sponsors to mitigate problems that may not actually exist. Conversely, models that underestimate concentrations may not fully expound the potential risks to sensitive populations. FHWA understands these concerns but requires technical support to better understand the performance of near-road dispersion models.

Since early 2020, Volpe Center staff have used in-depth knowledge of and expertise in emissions and dispersion modeling, and their ability to approach research questions from multiple angles, to help FHWA better understand the strengths and limitations of various dispersion model formulations and source characterizations.

A Volpe Center team conducted a performance evaluation of both the EPA-preferred regulatory model for highway emission sources, AERMOD,²¹ and a new research model, the Federal Highway Administration Highway Air Dispersion Model (FHWA Model) developed by the FHWA Resource Center. The Volpe team used measured near-road tracer gas concentrations from two historical datasets and compared those to modeled concentrations using

²¹ AERMOD Modeling System Development; <https://www.epa.gov/scram/aermod-modeling-system-development>.

AERMOD (including AREA, VOLUME, and the RLINE beta option) and the FHWA Model.

Findings from Volpe's evaluation showed the FHWA Model performed well under most meteorological conditions for the two tracer studies examined and were generally comparable to modeled concentrations using AERMOD. The Volpe Center continues to support FHWA dispersion model evaluation and research and aims to work with FHWA to publish the results for the benefit of the wider scientific and regulatory community. **Sponsor: FHWA, Office of Natural Environment**

AVIATION

Fly Neighborly Pilot Training Program Aims to Reduce Helicopter Noise Near Communities

Helicopter noise can be a concern in communities and metropolitan areas across the United States. In particular, New York City and the Los Angeles Basin are struggling to find noise-reducing solutions for helicopter tour and charter companies, as well as police and air ambulance operations.

Fly Neighborly is a voluntary noise reduction program created by the FAA and endorsed by Helicopter Association International (HAI). It seeks to create better relationships between communities and helicopter operators by establishing noise mitigation techniques and improving communications.²²

Fly Neighborly training equips pilots with abatement procedures and situational awareness tools they can use to minimize the impact of helicopter noise. Helicopter-model-specific noise abatement guidance has been developed by the Volpe Center in support of the FAA and in collaboration with NASA. FAA and the Volpe Center collaborated with NASA in the

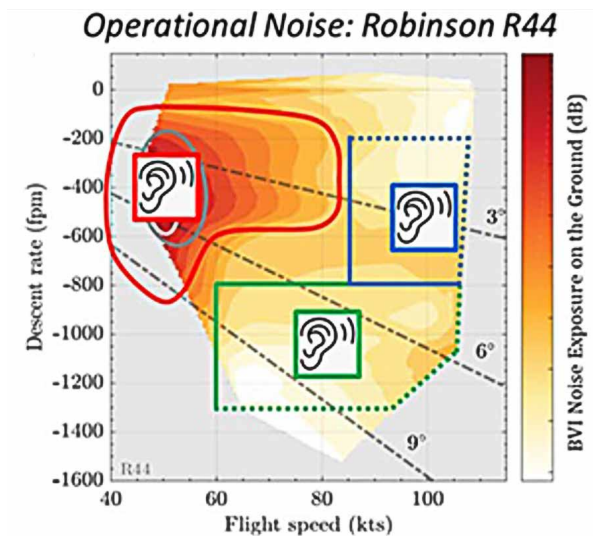
planning and execution of helicopter acoustic flight tests involving nine different helicopter models. The joint research resulted in a series of wide-area operational noise plots that provide guidance on reducing overall noise levels over a wide area, and directional (left-center-right) operational noise plots, which can be used to tailor additional noise reduction in specific areas relative to the flight operation. Based on pilot and operator feedback, the higher-fidelity directional operational noise training material has now been developed to supplement the program.

Volpe Center experts also developed and produced the content and narration testing of online Operational Noise training module webinars and eLearning modules for each of the tested helicopter models. The new training modules are based on higher-fidelity analysis of the empirical acoustical data and enable pilots to employ reliable and accurate decision making during preflight planning and in-situ flight. This process will help operators better operationalize the link between the helicopter's flight condition and its noise emission. The training also addresses safety, pilot workload, passenger comfort, as well as environmental justice and other sensitive land use considerations.

The modules provide actionable training for pilots and operators to help meet the needs of their local communities. The training modules were designed to help pilots anticipate the directional noise generated by the helicopter under different operating conditions. Pilots can then assess flight path, airspeed, approach descent rate, and deceleration rate to optimize flight patterns, during both the pre-flight planning stage and during real-time flight operations

In June, July, and August 2021, Fly Neighborly training webinars were held covering model specific noise abatement techniques for the Robinson R44, the Airbus AS350, and the Bell 407 helicopter models. These were hosted by HAI and attended by more than 400 people. Since 2018, the [Introduction to Fly Neighborly](#) training module has been completed by more than 670 people, and the Fly Neighborly auditory techniques module on the HAI Academy online training venue has been accessed by 145 people.

²² Fly Neighborly; <https://rotor.org/fly-neighborly/>.



A Robinson R44 operational noise diagram used in Fly Neighborly training, comprising wide-area directional plots. Significant benefits for noise abatement can be achieved if approach routes can be defined to keep noise sensitive areas to the far left or right side of the flight path. The greatest level of noise abatement overall occurred when keeping noise sensitive areas to the left side of the flight path. Source: NASA, edited by U.S. DOT Volpe Center

Additional eLearning modules are under development and planned for completion in FY 2021. Live Operational Noise training classes are also scheduled for presentation as part of the Rotor Safety Challenge during HAI HELI-EXPO in 2022. **Sponsor: FAA, Office of Environment and Energy**

Enhancing the Bureau of Transportation Statistics National Transportation Noise Map

According to recent forecasts, the U.S. population is expected to grow by 79 million people by 2060, and will cross the 400-million mark in 2058.²³ This

²³ Demographic Turning Points for the United States: Population Projections for 2020 to 2060; <https://www.census.gov/content/dam/Census/library/publications/2020/demo/p25-1144.pdf>.

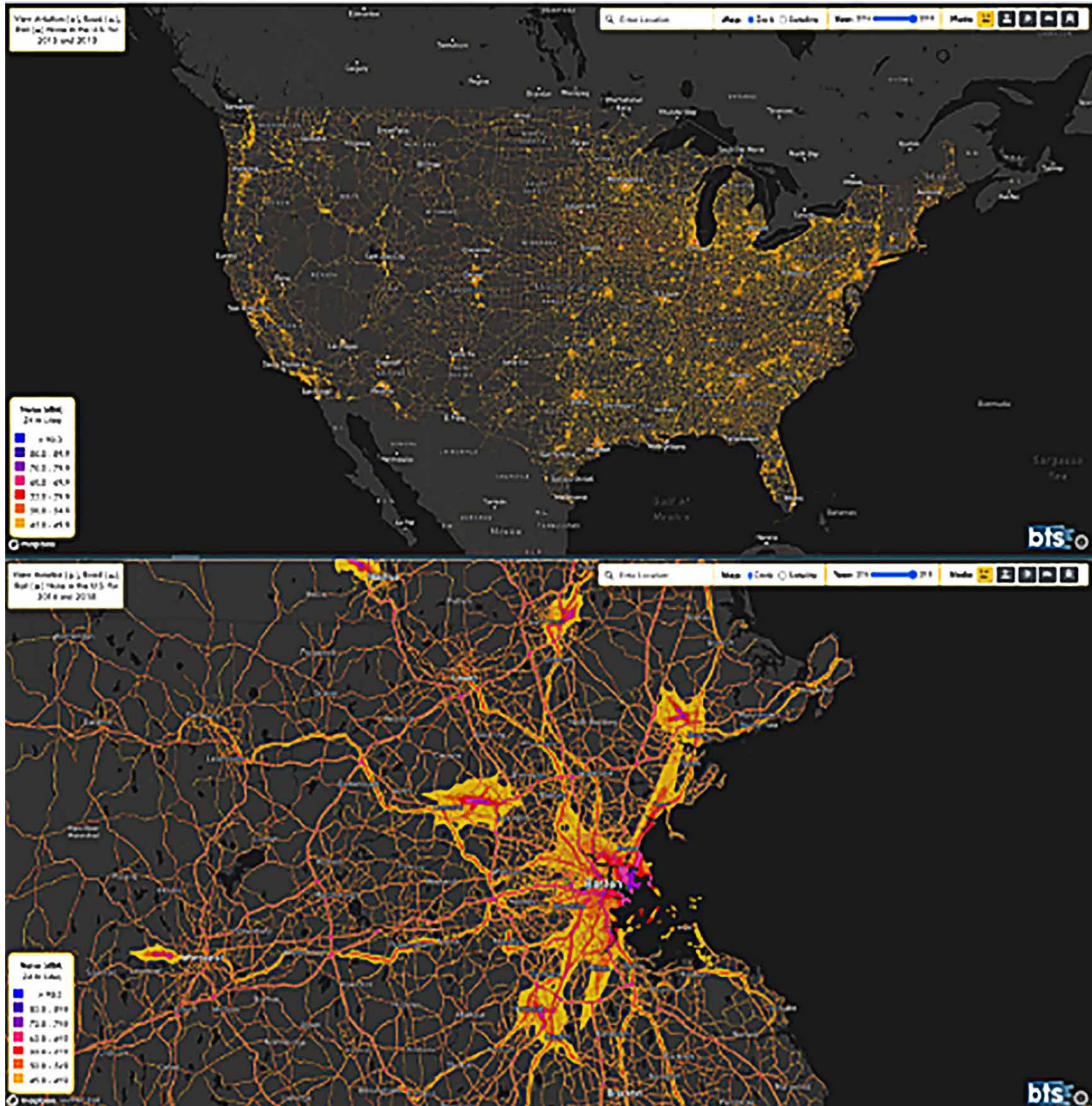
anticipated growth will increase the already high demand for different transportation modes. As demand increases, transportation-related noise will also change, which must be monitored to ensure environmentally appropriate levels are not exceeded. To meet this challenge, the Bureau of Transportation Statistics (BTS) initiated a national, multimodal transportation noise mapping initiative to track trends in transportation-related noise by mode collectively over time.

Because transportation noise is regulated by individual mode and most often analyzed on small areas, observing trends in transportation-related noise sources from different modes using the same national level noise metric can provide valuable insights. Example use cases for these data include analyzing the equity of potential noise impacts from transportation sources and analyzing changes in potential noise exposure due to changes in fleet or traffic patterns.

In 2017, BTS launched the National Transportation Noise Map to track trends in transportation-related noise, both individually by mode and collectively over time at the national level. The multimodal context this map provides can be used to better understand trends in transportation-related noise and highlight areas that may benefit from a more detailed analysis. The map can also be used by researchers for a variety of analyses that would otherwise not have access to noise data.

In support of the original launch, a Volpe Center team developed the first phase of the multimodal National Transportation Noise Mapping Tool (NTNMT), integrating aviation and road acoustics modeling results with GIS to create national, uniform noise level layers for each mode and for combined modes. These innovations enabled a state-by-state breakdown of sound level data for an annual average day for aviation and road noises.

In November 2020, BTS released the first biennial update of the National Transportation Noise Map. Aviation and road data acoustical inputs were updated to include 2016 and 2018 data. The transportation noise sources comprised in this release included airplane and road sources, which is consistent with the initial prototype release, and a prototype layer



Top: BTS National Transportation Noise Map displaying potential noise from aviation, road, and rail sources from 2016 and 2018. Source: <https://maps.dot.gov/BTS/NationalTransportationNoiseMap/> Bottom: BTS National Transportation Noise Map displaying potential noise from aviation, road, and rail sources from 2016 and 2018 for the Boston area. Source: <https://maps.dot.gov/BTS/NationalTransportationNoiseMap/>

for passenger rail sources was introduced for 2018 only. Significantly, the Volpe team expanded the

tool's acoustical modeling and GIS capabilities to also incorporate 2018 passenger rail noise.

A team of Volpe experts led the acoustics and geospatial modeling efforts and participated in outreach activities, including briefing stakeholders from the Office of the Secretary (OST), FAA, FHWA, FRA, FTA, and BTS. Additionally, the Volpe team developed software for modeling passenger rail noise at the national level, based on FTA and FRA guidance materials and spreadsheet tools. **Sponsor: BTS**

Volpe Center Helps Address Equity in Transportation

A top priority of President Biden and the U.S. DOT is to address long-standing equity issues across government programs. The Volpe Center supports this work by leveraging existing data sources to address some of the most pressing transportation-related questions on the minds of policymakers and legislators. The Volpe Center is providing expertise and technical support to multiple projects that research different aspects related to transportation equity.

U.S. DOT's Disadvantaged Business Enterprise (DBE) program exists to remedy ongoing discrimination, and the continuing effects of past discrimination, against small businesses owned and controlled by minorities and women in federally assisted contracting opportunities. One of the program's requirements is that business owners claiming disadvantaged status not have a personal net worth (PNW) above \$1.32 million. The \$1.32 million cap was established nearly 10 years ago and has not been updated. The U.S. DOT's Department of Civil Rights engaged the Volpe Center to determine how to update the cap in a manner that reflects current economic conditions and allows truly disadvantaged firms to continue participating in the program. The Volpe Center used a fresh approach to support this effort, relying on data from the Survey of Consumer Finances (SCF).

Executive Order 13985 required government agencies to conduct equity assessments of a selection of government programs. The Volpe Center assessed five discretionary grant programs using GIS techniques and the American Community Survey (ACS) to report the demographic characteristics of locations where transportation infrastructure projects for ports, railroads, airports, highways, and transit are located. The analysis can be used to develop a baseline understanding on how some underserved communities may also be overburdened communities, potentially exposed to negative externalities from the transportation network.

Mileage-based highway user fees are receiving increased

interest from policymakers, but have raised concerns about their equity impacts relative to other sources of transportation revenue. The Volpe Center is analyzing the potential distributional impacts across demographic and income groups of a revenue-neutral switch from a gas tax to a vehicle miles traveled (VMT) tax using data from the National Household Travel Survey (NHTS).

Infrastructure for Rebuilding America (INFRA) and Rebuilding America's Infrastructure with Sustainability and Equity (RAISE) are highly competitive grant programs that provide funding for freight and passenger transportation across multiple modes. An interdisciplinary team from the Volpe Center is assisting the Office of the Secretary (OST) with evaluating hundreds of project applications, including technical evaluation of merit criteria and/or benefit-cost analysis. This evaluation will help to ensure selected projects are aligned with program goals and societal benefits of scarce grant dollars are maximized. For 2021, program guidance incorporated addressing racial injustice and removing barriers to opportunity into existing selection criteria, which has informed the Volpe team's reviews.

Sponsor: OST Department of Civil Rights, FRA Office of Civil Rights, FHWA, BTS, and OST-P

MULTIMODAL

Department of Housing and Urban Development Noise Technical Evaluation and Policy Analysis

The mission of the Department of Housing and Urban Development (HUD) is to create strong, sustainable, inclusive communities and quality affordable homes for all. An array of legislative and regulatory mandates require HUD to be aware of potential noise issues, and to take positive steps to protect HUD grantees in residential and other sensitive land uses from high average noise levels. In the development of housing and other programs, HUD Community Development Block Grant and Urban Development Block Grant

recipients are therefore required to comply with federal environmental noise level standards to ensure conditions in HUD-assisted projects are safe and healthy for the people living there.

At HUD's request, in March 2020 the Volpe Center applied its noise policy and technical expertise to provide recommendations and methodologies to assist HUD and its stakeholders with responding to the regulatory requirements regarding noise exposure. This is the first major review of HUD's noise assessment methods since they were established more than 40 years ago. Key goals of this effort are to improve the:

- **Accuracy** of noise assessment, which will lead to better decision making and optimize the use of resources to protect people from unhealthy noise levels, and the
- **Simplicity** of noise assessment procedures, so that generalists without extensive expertise in acoustics can perform them.

Affordable housing can be protected from unacceptable noise levels and enhance access by being located near multiple transportation choices. Source: Ted Eytan/Flickr

Transportation modes such as highways, railroads, and airports are the main contributors to the environmental noise of concern to HUD. The Volpe Center was asked to compare HUD's noise assessment and mitigation methods with U.S. DOT's state-of-the-practice for noise assessment. The Volpe Center's recommendations seek to align HUD's and U.S. DOT's noise assessment methods, where practicable.

To clarify the relevant portions of existing HUD noise guidance and identify inconsistencies, a Volpe team reviewed HUD's noise-related regulations, related guidance as presented in the HUD Noise Guidebook, and associated training materials. Volpe also interviewed federal staff in every major HUD housing program to understand the benefits of the current noise policy, associated procedures, and assessment tools, as well as the challenges they present.

The Volpe Center's review compared HUD noise assessment methods with state-of-the-practice methods used by relevant U.S. DOT administrations to assess road, rail, aviation, and loud impulsive noise sources, and mitigation methods through barrier attenuation and acoustical construction. The Volpe team provided specific recommendations to clarify or



update guidance, update data and methods, and update noise assessment tools.

Volpe is developing a new HUD Noise Guidebook that will provide guidance on noise requirements, updating the explanation of the relevant regulations and HUD policies, and offering HUD an updated toolbox of noise assessment methods.

This Volpe-mediated collaboration between HUD and U.S. DOT creates connections that will serve to enhance equitable, affordable housing located near accessible transportation choices, and leverage/coordinate federal policies and investment. Additionally, aligning methods for noise assessment across the Departments enhances the benefits of research investments by both. **Sponsor: HUD**

WORKFORCE

Volpe Support for NCDOT Equity and Innovation Initiatives

For three years, the Volpe Center has provided research support to the North Carolina Department of Transportation (NCDOT) for several major equity initiatives and the reorganization of NCDOT's innovation structures and programs. As a partner in this work, the Volpe Center brought expertise to aid in assessing barriers to accessing the field of transportation technology as well as support in building a culture of innovation that can be developed at other state DOTs.

Volpe assembled a team of experts from across the Center's multiple disciplines to assist NCDOT in a broad range of activities. Building upon their experience in supporting other state DOTs and federal agencies, the Volpe team provided NCDOT with a variety of technical services, including quantitative and qualitative research, assessment and evaluation, and program and organizational development.

NCDOT recognizes that economic development in the U.S. has a deeply inequitable history tied closely to segregation, affecting access by minority communities to housing and jobs, and vital services that includes transportation. Addressing this history of inequitable access to transportation is a key component to expanding opportunities and creating an equitable future for all Americans.

Additionally, the current field of transportation technology in North Carolina and the nation has not included minorities at a rate consistent with their presence in the population. The emergence of new and innovative transportation technologies represents an important opportunity to address disparities faced by minority workers, entrepreneurs, and researchers. Advances in these technologies require significant research and development support, ample capital investments, a leadership focus on technology development, and entrepreneurs to build businesses based on new technologies.

To support NCDOT's work in this area, the Volpe Center assessed the status of opportunities for minorities in transportation technology within North Carolina and across the U.S., and how the state's 10 Historically Black Colleges and Universities (HBCUs) and one Minority Serving Institution (MSI) for Native American students can fill the need for qualified professionals and provide research and policy expertise to NCDOT.

The Volpe team conducted a literature review and analyzed census and employment data on multiple topics. The findings were synthesized into actionable insights captured in [Minorities in Transportation Technology: Baseline Industry & Demographic Trends 2020](#). The report highlights current inequities in employment, minority involvement in research, the presence of people of color in leadership positions in the industry, and opportunities for minority-owned business entrepreneurship. The report concluded that the field of transportation technology in North Carolina has not included minorities at a representative rate, and the emergence of new transportation technologies represents an important opportunity to expand access to the field to minority workers, entrepreneurs, and

researchers. The report also recommended that NCDOT adopt a multi-sector approach to develop and implement new programs that help expand access for minority groups in the transportation technology field.

To provide NCDOT with insights and policy recommendations regarding the involvement of HBCU/MSI students in this field, the Volpe team conducted site visits and interviews at each institution to assess and document current transportation research and the capacity for its expansion. In [Transportation Research Assessment of North Carolina HBCUs and MSI](#), the team describes the status of transportation research at each school; identified opportunities for NCDOT to conduct outreach and expand research engagement at HBCU/MSI institutions, citing key strengths as well as barriers to engagement with NCDOT; and suggested strategies for overcoming these barriers.

The Volpe team conducted interviews with national and state workforce development leaders, reviewed current research and publications, and drew from the HBCU/MSI Research Assessment to create a strategy for workforce development. The result, [Developing a School to Transportation Workforce Pipeline in North Carolina](#), identifies gaps, opportunities, and potential solutions to strengthen connections between students at those institutions and transportation technology career opportunities in the state.

Additionally, the Volpe team produced North Carolina HBCU Transportation Research Consortiums, an internal analysis of the types of consortiums best suited to specific North Carolina HBCUs/MSIs, and support NCDOT could provide these groups. Conclusions were based on the results of the transportation research readiness assessment the team conducted, and on techniques that such consortiums in other states have used to form, fund, and institutionalize their partnerships.

The culmination of these equity-related support efforts, developed in collaboration with leaders from eight Divisions across NCDOT, was *SEA-Change: A Strategic Equity Agenda*. SEA-Change is a blueprint for integrated, comprehensive, and measurable action items by NCDOT Units and Divisions to advance equity. It provides a set of forward-looking strategies for increasing equity as a framework for coordinating diversity, equity, and inclusion activities across the Department to increase equity within the transportation field. For this effort, the Volpe team drew information and data from the wide range of experience, expertise, and documentation of previous equity-related work at NCDOT and elsewhere, using draft plans from each NCDOT Division and the goals and priorities of participants.

In support of NCDOT's goal of building internal mechanisms to support innovation, the Volpe team provided direction for creating the charter for the North Carolina Transportation Innovation Council (NC-TIC) as well as guidance documents on how the Council should operate. The purpose of NC-TIC is to foster a collaborative culture within NCDOT to rapidly implement meaningful innovations and efficiently deliver a modern, high-quality transportation system to the public. Volpe staff conducted a series of interviews with other state DOT knowledge management and innovation programs to support the CLEAR (Communicate Lessons, Exchange Advice, Record) Program's rollout and ongoing implementation. The CLEAR Program collects lessons learned, innovative ideas, and best management processes to be shared throughout the Department. Lastly, Volpe assisted NCDOT in the creation and analysis of a survey to measure employee attitudes toward and engagement in innovation activities. **Sponsor: NCDOT**

An aerial photograph of a large-scale construction project. The main focus is a multi-story building with a modern glass facade. The upper portion of the building is completed, showing a grid of windows with a color scheme of white, blue, and green. A central vertical section is still under construction, with visible steel framing and a crane. The lower portion of the image shows the construction site, including a large concrete foundation, various construction materials, and equipment like a white pickup truck, a blue forklift, and a red truck. The sky is overcast. A semi-transparent yellow banner with a white circle on the left side is overlaid on the image, containing the text 'ORGANIZATIONAL EXCELLENCE' in white, uppercase, sans-serif font.

ORGANIZATIONAL EXCELLENCE

Source: U.S. DOT Volpe Center



The Volpe Center team helps to advance the U.S. DOT's mission by supporting transportation planning initiatives and helping to responsibly steward the public's resources.

Volpe Center Develops the U.S. DOT Strategic Plan to Guide Investments and Activities

The Government Performance and Results Act (GPRA) of 1993 requires federal agencies to develop a five-year strategic plan outlining its mission, long-term goals, performance measures, and reporting results. The FY 2022–2026 U.S. DOT Strategic Plan serves as a blueprint, describing the long-term goals the U.S. DOT aims to achieve, the actions it will take to reach those goals, and how the Department will efficiently use its resources. The Strategic Plan provides an evidence-based framework that includes an action plan for measuring success. In this way, it meets the requirements of both the GPRA Modernization Act and the Foundations for Evidence-Based Policymaking Act (the Evidence Act).

The U.S. DOT Strategic Plan aligns closely with the Biden-Harris Administration's priorities to deliver bold action to meet the needs of American families and address converging crises. These include taking action to control the COVID-19 pandemic, providing economic relief, tackling climate change, advancing racial equity, and restoring America's standing in the world.

The Volpe Center is helping to develop the U.S. DOT's Strategic Plan, which will guide the Department's investments and activities and meet the statutory requirements established in the GPRA. This plan will align the Department's efforts and investments with President Biden's priorities, including improving the safety of the transportation system, creating good paying jobs, growing an inclusive and sustainable economy, and building more resilient and sustainable transportation systems.

A Volpe team, in support of the Office of the Under Secretary of Transportation Policy, organized and facilitated a senior leadership discussion on strategic goals and objectives, and compiled and integrated feedback from across the Department to inform a draft framework including strategic goals, objectives, and strategies. Volpe staff are working to develop a full draft that includes performance measures and a learning agenda for the DOT workforce.

In December 2021, the U.S. DOT released a Request for Comments from the public. Volpe strategic planners will review and integrate feedback before completing a draft for submission to the Office of Management and Budget (OMB). This completed draft is expected to be submitted to OMB for review in late 2021, and the final Strategic Plan will be published in February 2022 along with the Department's budget. **Sponsor: OST-P**

How to Produce Better Cost Estimates for Medium- to Large-Scale Software Development Projects

Estimating the required labor and total costs of multiyear, large-scale commercial and government IT projects can be a difficult and time-consuming process. In a study published by the Standish Group, a review of 3,555 software development projects found that over half encountered challenges, meaning they were over budget, behind schedule, or did not meet the client's expectations. The Volpe Center recently published a thought leadership paper that examines the best practices in software estimation and planning, including recommendations for developing accurate scopes of work and realistic project schedules.

For project managers, the process of estimating the cost to develop, test, and implement large-scale software projects can be challenging. Software estimators can simplify the process by breaking down the task into smaller, more manageable pieces. The Volpe Center developed a checklist for estimating software projects and recommends consideration be given to the following key factors when estimating large-scale software development projects:

1. **Software development methodologies:** Select the appropriate project management and software development approach.

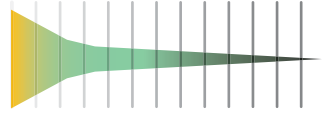
2. **The Cone of Uncertainty:** Project costs and schedules will fluctuate; building in contingencies will improve the overall outcome of a project.
3. **The importance of relevant experience:** Software estimators should build up their expertise over time, and can improve their skillset by estimating smaller portions of larger projects.
4. **Project startup and estimation components:** Discuss with clients and have a clear and common understanding of available budget and project estimates.
5. **Mechanisms for software estimation:** Select the right method or tool for producing estimates, either analogous, bottom-up, 3-Point, Constructive Cost Model, or commercial products like QSM SLIM-Estimate or SEER SEM.
6. **Project scope and schedule:** Find the right tools or mechanisms for managing fluctuations in project scope, estimates, and schedules.

Looking forward, software estimation and project management techniques must evolve as automation becomes increasingly sophisticated. The transportation domain of the future will see machine learning and other artificial intelligence (AI) approaches integrated into vehicles, risk models, data analysis, and safety management systems. Software developers will need to estimate automation projects supporting advances in autonomous vehicles, vehicle-to-vehicle communications, transportation equity models, climate change simulations, and other transportation-related innovations. AI and machine learning will play a greater role in how the government estimates software costs, scopes of work, and schedules.

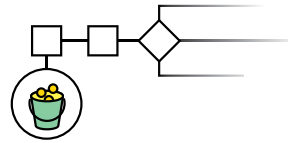
For additional information and to view the Volpe Center's report, please visit the [National Transportation Library website](#). **Sponsor: U.S. DOT Volpe Center**

CHECKLIST FOR ESTIMATING SOFTWARE DEVELOPMENT PROJECTS

- 1. Elaborate designs as far down **the Cone of Uncertainty** as possible, even if this means making a few assumptions.



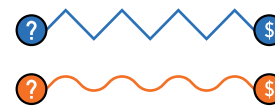
- 2. Before initiating a project, have a **risk reserve** and a method in place for managing changes in project scope.



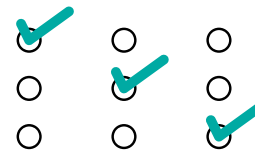
- 3. Ensure **sponsors fully understand** the project's scope and the methods that were used to produce the software estimates.



- 4. Always use **at least two** methods to estimate project cost and remember to compare the estimates generated by each method.



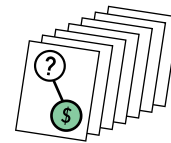
- 5. When using SEER-SEM or similar products, it is especially important to calibrate SEER model parameters by comparing SEER output with estimates produced using other methods to **ensure that SEER model parameters are set correctly**.



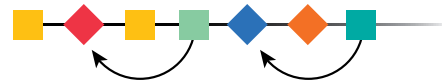
- 6. Develop a **realistic project schedule** in conjunction with the cost estimate.



- 7. Keep a **database of actual costs and estimates** from previously estimated projects.



- 8. If possible, **re-estimate project costs** during the software development life cycle.





SMALL BUSINESS INNOVATION RESEARCH (SBIR)

Source: Adobe Stock



Small Business Innovation Research Technology Readiness Level Expansion

U.S. DOT's highly competitive Small Business Innovation Research (SBIR) Program awards contracts to domestic small businesses to pursue research on and develop high-priority innovative solutions to our nation's transportation challenges. The U.S. DOT SBIR Program favors research that has the potential for commercialization through products and applications sold to the private sector transportation industry, state DOTs, U.S. DOT, or other federal agencies. Funding in Phase I is awarded for exploratory research; Phase II awards are made for principal research or R&D efforts, based on results achieved in Phase I. A Phase II awardee may receive one additional, sequential Phase II award (known as a Phase IIB award) to continue the work of an initial Phase II award. The intent of Phase IIB awards is to advance and/or accelerate Phase II SBIR-funded technologies toward commercialization.

To support the SBIR Program's Phases II and IIB, the Volpe Center designed and is implementing a series of Technology Readiness Level (TRL) Assessments in an effort to support participating small businesses as they mature their research. The TRL Assessments were first piloted in 2019 in support of FHWA's SBIR awards. Although TRLs have not yet been applied to other operating administrations' SBIR awards, it is a tool that can support SBIR research by providing valuable feedback to help researchers further mature their work.

In 2021, Volpe led the development of two complementary modules for the TRL assessment: the Technology Readiness Baseline Assessment (Baseline Assessment) at the beginning of Phase II, and the


Deployment Readiness Level Assessment (Deployment Assessment) at the end of Phase IIB. These are intended to provide additional opportunities for small business awardees to solicit feedback, while also providing FHWA with a better understanding of the commercialization potential of the research.

The Baseline Assessment expansion was developed to aid the small business by providing a foundational TRL score that helps highlight opportunities to strengthen the project's commercialization readiness, thus improving the likelihood of a successful Phase II. The Deployment Assessment, which occurs later in the SBIR process, offers the small business a final opportunity at the end of their Phase IIB to receive feedback from the FHWA team, and to provide FHWA with additional data to improve the SBIR TRL process.

Proposed projects that receive SBIR awards are typically innovative and novel in the transportation solution they intend to solve. The Baseline and Deployment Assessment modules provide more opportunities for small businesses to receive feedback regarding the potential of their project for technology commercialization, which has more impact than technology that remains as applied research.

To date, two Baseline Assessments have been conducted, both during summer 2021. These provided an opportunity for the FHWA Contracting Officer Representative and the small businesses to have an informal update on their proposal's trajectory toward commercialization. Baseline Assessments will also be used in the future to familiarize the participating small businesses with the TRL process.

Assessment activity is expected to accelerate in February 2022. **Sponsor: FHWA**



THOUGHT
LEADERSHIP

Source: Adobe Stock



The U.S. DOT Volpe Center looks beyond the horizon to anticipate future transportation issues and discuss fresh approaches to emerging transportation challenges.

Between May and October 2021, the Volpe Center's "Innovation for a Sustainable, Equitable Transportation System" brought together thousands of people from around the world to hear insights and perspectives from eight prominent public, private, and academic transportation professionals. U.S. Transportation Secretary Pete Buttigieg opened the series and welcomed participants after an introduction by Deputy Assistant Secretary for Research and Technology Robert Hampshire.

The annual speaker series pivoted to an exclusively virtual experience in response to the Covid-19 pandemic. This format enabled the Volpe Center to showcase guests located across the U.S., and expanded opportunities for listeners to participate in dialogue with guests. Volpe Center Director Anne Aylward hosted and moderated each of the six events.

The Volpe Center's mission is to advance transportation innovation for the public good; it is uniquely positioned to convene thought leaders who raise challenging questions and offer novel solutions to the most pressing problems facing our transportation enterprise.

The speakers explored how the transportation enterprise can work together to address the profound climate crisis while ensuring decision making and investments also address transportation equity. Solutions to these complex challenges require a holistic approach to transportation emissions reduction and the development of significantly enhanced equity and sustainability initiatives.



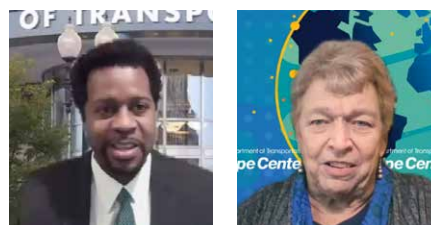
As we innovate toward a clean energy future, this series considered how to transition to a low-/no-carbon transportation system—one that enables disadvantaged communities to gain access to mobility, jobs, and economic opportunity.

Speakers brought their bold visions for energy sector transformation to achieve net-zero emissions, urban electrification, and techno-economic pathways from the microeconomic, such as individual subsidies to incentivize travel behavior—to the macroeconomic, such as creation of regional cap-and-invest carbon markets.

They challenged transportation professionals to think critically about the ways in which communities that have borne a disproportionate burden of transportation emissions' health and environmental impacts can be centered in, and central to, planning and development processes at local, regional, state, and federal levels, and in public, private, and academic sectors.

This section recaps highlights of the 2021 thought leadership series.

Video highlights are posted at www.volpe.dot.gov.



(Top) U.S. Transportation Secretary Pete Buttigieg opened the series. (Above left) Deputy Assistant Secretary for Research and Technology Robert Hampshire delivered remarks and introduced the Secretary. (Above right) U.S. DOT Volpe Center Director Anne Aylward hosted and moderated the series.

Source: Adobe Stock



SECRETARY PETE BUTTIGIEG

U.S. DEPARTMENT OF TRANSPORTATION

Kick-off Event / Innovation for a Sustainable, Equitable Transportation System

Moving beyond the Coronavirus pandemic offers an opportunity to leverage innovation in service of public policy goals. The enormous challenges of the past year offer enormous opportunities to identify the “era-defining climate and equity innovations of our time.” To this end, Secretary Buttigieg highlighted the power of vehicle electrification and automated technologies to transform not only individual travel behavior, but also economic activity, land use patterns, and housing trends. Partnerships and collaboration among all federal departments, and with state DOTs, metropolitan planning organizations, and municipalities can help U.S. DOT create a cleaner, more equitable transportation system.

“When we place public investments the right way, it unleashes a scale effect that makes it truly transformative.”

ROBERT C. HAMPSHIRE, PHD

DEPUTY ASSISTANT SECRETARY FOR
RESEARCH AND TECHNOLOGY
AND CHIEF SCIENCE OFFICER
U.S. DEPARTMENT OF TRANSPORTATION

Introduction / Innovation for a Sustainable, Equitable Transportation System

For the first time in a generation, Dr. Hampshire is filling the role of U.S. DOT’s Chief Science Officer, in addition to his role as Deputy Assistant Secretary for Research and Technology. By making a commitment to staying engaged with cutting-edge science and scholarship—including climate science, energy research, AI and big data, and other related disciplines—the Department can consider fresh approaches to solving complex problems. Although we are facing mounting challenges, this is a pivotal time for innovation around sustainable and equitable transportation systems.

“This is a pivotal and exciting moment for discussions of sustainability and equity within transportation.”



Source: Adobe Stock

Source: Adobe Stock



JAMES BRADBURY, PHD

**MANAGING PROGRAM DIRECTOR
GEORGETOWN CLIMATE CENTER
GEORGETOWN UNIVERSITY LAW CENTER**

The Transportation and Climate Initiative: Multi-State Collaboration to Advance Equitable Low-Carbon Transportation

The Transportation Climate Initiative (TCI) is a regional collaboration of 13 Northeast, Mid-Atlantic, and Southeast states and the District of Columbia designed to create equitable and just low-carbon transportation policies and programs.

A “cap-and-invest” approach establishes an emissions cap for regulated fuel suppliers and a marketplace for auctioning CO₂ emissions credits. Participating jurisdictions then invest the proceeds from those auctions in low-carbon strategies that reduce pollution, advance equity, and provide expanded and diversified transportation choices.

Modeling shows that the cap-and-invest program can reduce CO₂ emissions by 26 percent between 2022 and 2032.

“I’ve come to believe that state leadership is fundamental for the U.S. to make steady progress on the climate and equity.”



Source: Adobe Stock

MARILYN A. BROWN, PHD

**REGENTS' AND BROOK BYERS PROFESSOR
OF SUSTAINABLE SYSTEMS
SCHOOL OF PUBLIC POLICY
GEORGIA INSTITUTE OF TECHNOLOGY**

*Advancing a Just and Low-Carbon
Future with Urban Electrification*

The 2020s will be a “decisive decade” because solutions to the climate crisis will be critical to long-term prosperity. Urbanized areas and cities, which globally consume about 75 percent of energy and generate 75 percent of worldwide CO2 emissions, are at the forefront of the emerging field of urban electrification. This includes not only electric vehicles (EVs), but increases in the use of electric heat pumps, induction ranges, and advanced manufacturing using electrified equipment. The transportation sector will likely undergo the most rapid increase in electrification; so long as the grid is producing electricity with renewables, drastically lower transportation-related CO2 emissions will shift from aspirational to achievable.

“A policy makeover is needed to promote an equitable energy transition across all sectors of the economy.”

ED CARR, PHD

**DIRECTOR AND PROFESSOR
INTERNATIONAL DEVELOPMENT, COMMUNITY,
AND ENVIRONMENT DEPARTMENT
CLARK UNIVERSITY**

*A Climate-Resilient Future Is an Equitable,
Just Future*

Resilience “is not a response to specific impacts;” rather, it is the combination of responses over time and can result in new vulnerabilities that affect different community groups in profoundly different ways. Human vulnerability to climate change has three components: exposure, sensitivity, and adaptive capacity, and huge variability in terms of impacts and adaptive capacity. In addressing climate change, the only effective response to safeguard and promote our future well-being is major transformational change, including decarbonization and framing our work through an equity lens.

“That which makes us resilient also shapes the character of our vulnerability.”



Source: Adobe Stock



Source: Adobe Stock

DR. SHELLEY FRANCIS

**CO-FOUNDER AND PRINCIPAL
EVNOIRE**

*Mobility Best Practices and E-Mobility
Diversity, Equity, and Inclusion in Accelerating
EV Adoption*

A focus on diversity, equity, and inclusion (DEI) in transportation and land-use policy could be one element of a restorative justice approach to address public policies enacted generations ago that bisected historically Black and Brown communities, leaving a legacy of isolation and lack of access to services.

Expanded EV charging infrastructure in minority and economically diverse communities can promote cleaner roadway transportation options in the form of plug-in EVs (PEVs), raise awareness about “charging deserts,” and break down barriers to EV ownership in communities of color. Community-led solutions can create more inclusive ideas and practices around electrification and EV adoption.

“We are working to advance equitable e-mobility solutions ... that are connected, shared, autonomous technologies.”

ERIN MAYFIELD, PHD

**SUSTAINABLE SYSTEMS ENGINEERING
AND PUBLIC POLICY RESEARCHER AND
POSTDOCTORAL SCHOLAR**

**ANDLINGER CENTER FOR ENERGY AND THE
ENVIRONMENT AND THE HIGH MEADOWS
ENVIRONMENTAL INSTITUTE**

PRINCETON UNIVERSITY

*Net-Zero America: Potential Pathways,
Infrastructure, and Impacts*

To realize domestic and global imperatives to reduce carbon emissions, researchers like Dr. Mayfield and the Net-Zero America team are leveraging a multidisciplinary approach to modeling “least cost” alternative techno-economic pathways to emissions targets by 2050.

Transitioning to net-zero carbon emissions by 2050 will require significant mobilization of capital, and an up-front investment of more than \$3 trillion in the 2020s alone.

“The rate of decarbonization is influenced by the ... availability of labor with the requisite experience, skills, and education.”



Source: Adobe Stock

Source: Adobe Stock



SUSAN SHAHEEN, PHD

**CO-DIRECTOR
TRANSPORTATION SUSTAINABILITY
RESEARCH CENTER
INSTITUTE OF TRANSPORTATION STUDIES
UNIVERSITY OF CALIFORNIA, BERKELEY**

Strategies to Overcome Transportation Barriers for Rent-Burdened Residents

Shared mobility is a transportation option that can meet environmental, sustainability, and equity goals by offering rent-burdened travelers lower-cost and lower-emissions options.

Researchers uncovered key barriers to the widespread adoption of on-demand shared mobility services such as lack of familiarity, high or unexpected costs, lack of vehicles, and the need to use an assortment of unique and different smartphone apps to access services provided by different private vendors. Discounted or fare-free transit, integrated mobility digital wallets, and a focus on an expanded group of users—the rent-burdened—can have significant impacts on regional transportation systems.

“[Rent-burdened residents] cite public transit fares as a major financial barrier” that “constrained their ability to look for jobs.”

TIM WALLINGTON, PHD

**SENIOR TECHNICAL LEADER
RESEARCH & ADVANCED ENGINEERING
FORD MOTOR COMPANY**

Toward Carbon Neutral Mobility

Ford Motor Company, which invests in a team of scientists and engineers who study climate change, energy, sustainability, and innovation, has made a corporate commitment to doing its part and aspires to achieve carbon neutrality by 2050.

Life cycle analysis of carbon emissions produces a comprehensive and wide-ranging output and revealed that fuel use dominated the emissions life cycle; aggressive plans for electrification are necessary to achieve climate goals. Recent research shows significant progress in battery efficiencies and potentially higher demand based on new federal and state climate policies and regulations.

“Addressing climate change is arguably the most difficult task ever undertaken by humanity.”



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Speaker Series Reaches 33 Countries on 6 Continents

Each year the Volpe Center's speaker series brings together people from around the world for stimulating lectures and dialogue about urgent transportation issues. This year was no different; the 8 events generated more than 9,000 registrations from 33 countries on 6 continents.

Each event featured a 30-minute expert talk plus another 30-minute moderated question-and-answer session. Attendees had a unique opportunity to hear live and direct responses to their questions from academics, industry leaders, and this year, Secretary of Transportation Pete Buttigieg.

This year, the Volpe Center hosted its thought leadership series entirely online. Between 600 and 2,100 people registered for each of the events, and half of registrants attended the midday lectures. Thought leaders spoke on profoundly important topics like equity and environmental justice, decarbonization, and transformational technologies.

Across the 2021 series, more than half (53 percent) of attendees were affiliated with the private sector, or with state, tribal, regional, or local governments. One third of attendees were affiliated with federal departments, offices, and programs where innovative transportation ideas can be evaluated and implemented.

The Volpe Center is based in Cambridge, MA in proximity to major universities, technology firms, and research centers. But the reach of this year's virtual thought leadership series extended far beyond the Volpe Center's doors, bringing together transportation thinkers and professionals across all 50 U.S. states, and territories that included the U.S. Virgin Islands and Puerto Rico.

This broad participation underscores the nationwide urgency to consider sustainable, equitable innovations in a domestic transportation network that is increasingly vulnerable to the impacts of climate change, but also increasingly the focus of massive strategic public investments. International participation from Europe, the Middle East, Asia, and Oceania speaks to the universality of the issues the 2021 thought leadership series brought to light.

Speaker Series: The Response

The 8 events of 2021's speaker series, **Innovation for a Sustainable, Equitable Transportation System**, generated

more than **9,000** registrations
from **33** countries on **6** continents.



34% Federal Government

30% State, Tribal, Regional, Local Government

23% Private Sector

7% Academia



Source: © Rijkswaterstaat

VIRTUAL INTERNATIONAL SEMINAR

Energy Transition in Transport: National Policy and Local Implementation

Since 1998, the Volpe Center has cooperated with Dutch transportation officials to exchange information, expertise, and innovative ideas. This year's virtual seminar included six speakers and approximately 50 participants. The dialogue centered on decarbonization and energy transition in the transportation sector in response to threats from climate change.

Deputy Assistant Secretary for Research and Technology and DOT Chief Science Officer Robert

Hampshire, and Marlouke Durville, the Managing Director Rijkswaterstaat, Water, Transport and the Environment at the Netherlands Ministry of Infrastructure and Water Management provided introductory remarks. Volpe Center Director Anne Aylward moderated the session.

National Governments Recognize the Imperative to Act

The U.S. perspective, according to Dr. Hampshire, is informed by the 2021 Bipartisan Infrastructure Law (BIL), which provides a massive federal infrastructure investment to states, regions, and cities to reduce transportation emissions and strengthen the resilience of the transportation network by shifting towards vehicle electrification and supporting alternatives like

public transit, all while centering equity considerations and economic competitiveness.

Climate threats and the imperative to decarbonize are major topics of concern in the Netherlands, too. Durville highlighted the country's centuries-long experience with water management necessary to create sustainable, accessible cities. Today, the Netherlands' federal agencies are working towards net-zero energy use and incorporating sustainable energy infrastructure into transportation projects, all while remaining economically robust.

Multiple Perspectives on Energy Transition

National strategies in the two countries are rooted in a common goal but take different forms. Berube highlighted the U.S. commitment to vehicle electrification and research investments in hydrogen and biofuels in the aviation sector. In the Netherlands, electrification of vehicles is strong and ongoing (the Netherlands hosts fully 25 percent of Europe's charging stations), so the national strategy includes an overall reduction in energy use by building and maintaining infrastructure for low- or no-carbon transportation modes. While the U.S. emphasizes the growth of new private markets and technologies, the Netherlands combines taxation measures to incentivize travel choices with support of regional government climate and transport strategies.

Comprehensive Approaches to Implementation

Strategies and plans are effective only when they are implemented. Bradbury and Buursink shared approaches to realizing emissions and energy-use reductions through integrated land-use and transportation planning. Dr. Bradbury's work to convene a multi-state, multi-jurisdictional group of stakeholders has resulted in successful shared and

innovative tools. In Amsterdam, a keen understanding of the process of "metropolization" or urban expansion underpins development models that link vehicle infrastructure with hubs that connect travelers to alternative mobility options such as cyclepaths, tramways, and other transit.

The virtual seminar sparked lively discourse around the most effective use of alternative fuels in transportation and other sectors, sustainable land-use and spatial development patterns, and the different organizing approaches for ensuring justice, equity, and access for all stakeholders of the transportation network.

Expert guests

MICHAEL BERUBE

**DEPUTY ASSISTANT SECRETARY FOR
SUSTAINABLE TRANSPORTATION**

**OFFICE OF ENERGY EFFICIENCY
AND RENEWABLE ENERGY**

U.S. DEPARTMENT OF ENERGY

PIETER LITJENS

**CHAIR OF THE STAKEHOLDER TABLE
FOR MOBILITY OF THE DUTCH
CLIMATE AGREEMENT**

DR. JAMES BRADBURY

**MITIGATION PROGRAM DIRECTOR
GEORGETOWN CLIMATE CENTER**

ERRIK BUURSINK

**CHIEF URBAN PLANNER
CITY OF AMSTERDAM**



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REPORT DOCUMENTATION PAGE			<i>Form Approved</i> <i>OMB No. 0704-0188</i>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE January 2022		3. REPORT TYPE AND DATES COVERED Final Report
4. TITLE AND SUBTITLE Volpe Center Annual Accomplishments – January 2022				5a. FUNDING NUMBERS
6. AUTHOR(S) Prepared by the Volpe Center’s Office of Strategic Initiatives for Research and Innovation in collaboration with the leadership and staff of the U.S. DOT Volpe Center’s Technical Centers for Safety Management and Human Factors; Policy, Planning and Environment; Infrastructure Systems and Technology; and Air Traffic Systems and Operations. Nathan Grace served as publication coordinator and project manager and Philip Thornton as art director. Editing, writing, and production: Tess Perrone, Ingrid Bartinique, Cassandra Oxley, Cassandra Raposo, and Alexa Rockwell.				5b. CONTRACT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Office of Strategic Initiatives for Research and Innovation U.S. Department of Transportation John A. Volpe National Transportation Systems Center 55 Broadway Cambridge, MA 02142-1093				8. PERFORMING ORGANIZATION REPORT NUMBER DOT-VNTSC-22-03
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Department of Transportation John A. Volpe National Transportation Systems Center 55 Broadway Cambridge, MA 02142-1093				10. SPONSORING/MONITORING AGENCY REPORT NUMBER
11. SUPPLEMENTARY NOTES Prepared under the direction of Ellen Bell, Director of Strategic Initiatives for Research and Innovation.				
12a. DISTRIBUTION/AVAILABILITY STATEMENT This document is available to the public on the Volpe website: https://www.volpe.dot.gov .				12b. DISTRIBUTION CODE
13. ABSTRACT (Maximum 200 words) The Volpe Center’s Annual Accomplishments highlights our best work of 2021 and illustrates the sustained impact of the Volpe Center in supporting the U.S. DOT’s top priorities and strategic goals: safety, climate solutions and sustainability, transformational innovation, economic strength and global competitiveness, transportation equity, organizational excellence, and small business innovation research (SBIR). This year’s publication highlights over 50 projects carried out in support of and in collaboration with the U.S. DOT and other sponsors. It also features highlights from the Volpe Center’s 2021 Thought Leadership speaker series “Innovation for a Sustainable, Equitable Transportation System.”				
14. SUBJECT TERMS Volpe Center, 2021 annual accomplishments, climate solutions, transportation equity, road safety, infrastructure, innovation, organizational excellence, automation, automated vehicles, electric vehicles, long range planning, fuel economy, environmental impacts, human factors, COVID-19, international partnerships, motor carrier safety, electronic flight bags, transportation data, multimodal application, data modernization, software development, transportation performance management, transportation planning, environmental analysis, policy analysis, noise mitigation.				15. NUMBER OF PAGES 88
				16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT		18. SECURITY CLASSIFICATION OF THIS PAGE		19. SECURITY CLASSIFICATION OF ABSTRACT
20. LIMITATION OF ABSTRACT				

