The U.S. Department of Transportation's Volpe Center

Advancing Data-Driven Decision Making in Transportation

U.S. Department of Transportation
Volpe Center

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Novel **data analysis techniques** are transforming mobility in the U.S. and around the world. This is how the U.S. DOT Volpe Center is applying its unique capabilities across the data spectrum—**modeling and visualization, machine learning, modernization,** and **analysis and collection**—to inform decision making and **improve the safety and efficiency** of **multimodal transportation systems**.

Innovative Approaches to Modeling and Data Visualization

Integrating Safety Data with the Waze Pilot Project

More than 37,000 people were killed in motor vehicle crashes in 2017. In addition, over 3 million were injured in motor vehicle crashes in 2016. To understand crash risk, the U.S. Department of Transportation (DOT) Safety Data Initiative is using advanced data analytics to identify factors that contribute to serious crashes.

In support of the Office of the Under Secretary for Policy and the Bureau of Transportation Statistics, Volpe Center data experts are leading the Waze Pilot Project, which is advancing U.S. DOT's vision of integrating government data with big data from private companies to estimate crash risk and indicate reportable traffic crashes in a reliable and timely way.

In phase one of the Waze project, a Volpe Center team integrated traffic event data with police-reported traffic crash data and other variables, such as weather and roadway conditions. The team applied machine learning methods to estimate the number of police-reportable traffic crashes that occurred every hour in one-mile area grid cells across Maryland from April to September 2017.

In phase two, the U.S. DOT Volpe Center is partnering with state and local transportation agencies to develop specific applications of the Waze crash estimation models, and assess how they can inform traffic safety. ■

Safely Introducing Drones into the Nation's Airspace

Federal regulation requires that pilots be aware of surrounding aircraft—either visually or with on-board instrumentation. Remote Unmanned Aircraft System (UAS) operators cannot safely comply with this regulation. Remote UAS operators must resort to limiting and sometimes impractical ways to see and avoid other aircraft, such as ground-based observers or chase aircraft following the drone.

Experts in air traffic management and operations at the Volpe Center have worked with the U.S. Air Force to develop and deploy an automated solution to this challenge.

Ground-based detect and avoid (GBDAA) integrates real-time track and position data from ground-based radar into a single display, allowing remote UAS operators to detect and avoid other aircraft.

Volpe experts also engineered an innovative solution—a mobile command center outfitted with a full suite of GBDAA equipment—that allows remote pilots to control UAS operations from multiple locations. The deployment is an important benchmark, demonstrating that GBDAA can be effective across geographic locations with unique operational characteristics. ■
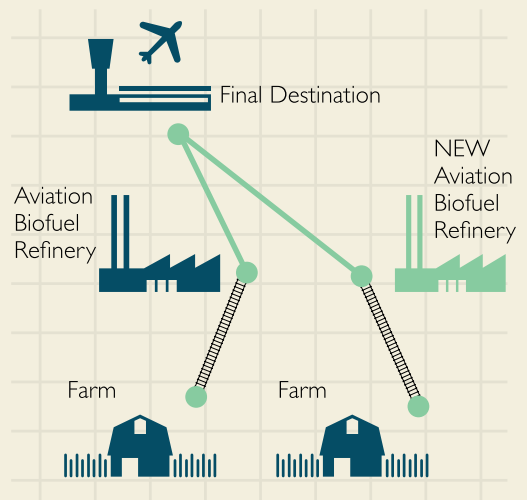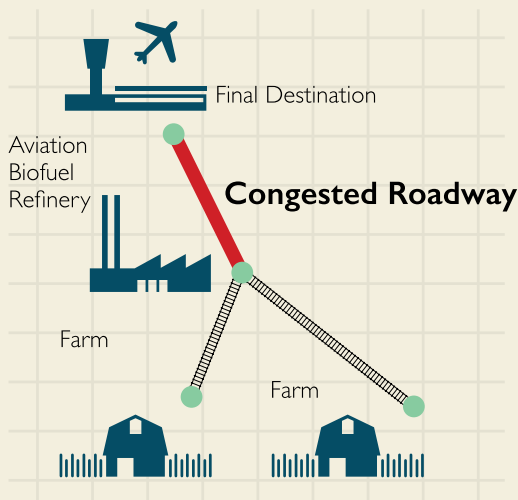
Using the Freight and Fuel Transportation Optimization Tool to Evaluate Transport Scenarios

The U.S. economy depends on the efficient movement of goods, including critical energy commodities. Government agencies are working to understand changing transportation needs and potential impacts.

To analyze freight and fuel transport options, Volpe created the Freight and Fuel Transportation Optimization Tool (FTOT) on behalf of the Federal Aviation Administration (FAA), the Department of Energy (DOE), and the U.S. Navy's Office of Naval Research.

Exploring Transportation Flow Scenarios with the Freight and Fuel Transportation Optimization Tool (FTOT)

The **U.S. DOT Volpe Center** created FTOT in support of FAA, DOE, and the Department of Defense (DoD) to analyze freight and fuel transport options. In this simple example, FTOT can show how a new biofuel refinery and new roadway might impact traffic flow.

Final Destination
Aviation Biofuel Refinery
Congested Roadway
Farm
Farm

Final Destination
Aviation Biofuel Refinery
NEW Aviation Biofuel Refinery
Farm
Farm

FTOT draws on a range of data to help government agencies analyze freight and fuel transport options and hone in on optimal multimodal transportation flow patterns and emissions associated with potential freight and energy scenarios.

Users can explore how potential changes in production and demand will affect those optimal patterns. FTOT users can also evaluate how future infrastructure scenarios will affect a given route, and apply what they learn to freight planning. The Volpe team continues to enhance FTOT's capabilities and is working toward a publicly releasable version of the tool, expected in 2019. ■

Improving Data Visualization and Access Across Aviation

FAA is a data-rich organization, but historically has not had a standard mechanism for sharing data between programs and with aviation stake-holders. By standardizing delivery methods and building data delivery into the FAA infrastructure, data-sharing costs are greatly reduced and secure data-sharing options are maximized.

Data sharing improves transportation efficiency and reduces delays by providing common situational awareness and improved planning capabilities.

Volpe Center experts have been vital in developing the System Wide Information Management (SWIM) Program, which improves data sharing across the aviation community using defined, standardized, secure, flexible, and scalable connections. With SWIM, airlines no longer need to scour numerous sources to access weather and surface operations information. Private industry can also capitalize on SWIM-distributed air traffic control data to develop new software products that serve the aviation community. ■

Sharing Data to Advance Safety and Security on the Global Seas

Volpe used its data and system engineering expertise to develop a maritime domain awareness data-sharing network known as the Maritime Safety and Security Information System (MSSIS) for the U.S. Navy 6th Fleet.

MSSIS is a low-cost, unclassified, near real-time network that is used to track vessels as they traverse the world's waterways.

The system tracks tens of thousands of vessels and is an invaluable tool for security forces globally, providing support for international military operations and exercises, as well as search-and-rescue missions. ■

Helping to Automate Approval of Drone Operations

FAA projects an increase from 1.1 million small-model hobbyist Unmanned Aircraft Systems (sUAS) in 2017 to 2.4 million in 2022, and from 110,604 commercial, small non-model drones in 2017 to 451,800 in 2021. FAA asked the Volpe Center to develop a quantitative model to evaluate the automated approval of sUAS operations using the new Low Altitude Authorization and Notification Capability (LAANC) system.

Volpe Center experts analyzed manned aircraft track data from over 40 airports to determine altitudes and sufficient vertical separation between drones and other aircraft.

Volpe used the model it developed to analyze airspaces using a data-backed, quantifiable, and repeatable approach. Quantitatively assessing airspaces can improve the safety of sUAS operations and increase the reliability of automated approval systems. With detailed data on manned aircraft traffic, FAA can approve requests to fly sUAS faster and more efficiently. ■

Machine Learning

Addressing Driver Behavior to Improve Safety

Driving behavior is a critical factor in nearly all traffic crashes. The Second Strategic Highway Research Program's (SHRP2's) Naturalistic Driving Study (NDS) provides information on driving behavior and individual trip characteristics—including events like crashes and near crashes.

Naturalistic driving research requires extensive access to supporting video data, recorded continuously while drivers operate vehicles. Traditional manual data reduction techniques are cumbersome, expensive, and sometimes impossible.

Volpe Center machine learning experts developed the methodology, example technology, and subject matter expertise needed to create a video processing tool.

Volpe staff then developed that solution using agile workflow methods, and continue to add new features to the application.

This project is now focused on detecting and mapping features related to work zones, traffic signals and signal state, and road weather conditions. Volpe produced a tool that can detect and map work zone features with over 90 percent accuracy across the video data set.

Using machine learning techniques, analysts can process a one-hour video in 30 seconds using commercial-grade computer processors, compared to three to four hours for manual coding. Reducing the time needed to perform NDS research also makes the SHRP2 data set more useful for research on validating work zone models. ■

(Photo: ©123rf.com/Natalia Ramirez Roman)

Modernization

Improving Motor Carrier Safety through State-of-the-Art Technology

The Federal Motor Carrier Safety Administration (FMCSA) aims to make highways safer for all drivers. One danger is fatigued driving, which leads to hundreds of crashes and deaths each year. Federal law requires that trucks have electronic logging devices (ELDs), which track on- and off-duty time for drivers.

ELDs create a safer work environment for drivers of commercial motor vehicles, and make it easier and faster to accurately track, manage, and share data on driving and off-duty time. FMCSA estimates that nationwide ELDs can help avoid 1,844 crashes, with 562 fewer injuries and 26 lives saved per year.

The Volpe Center designed and developed the technology for transmitting ELD data to safety officials, and a software application—Electronic Records of Duty Status, or eRODs—for viewing and analyzing that data. Volpe experts also designed and delivered communication and outreach materials, including a website that is the program's information centerpiece: https://eld.fmcsa.dot.gov.

Finally, the Volpe team provides critical technical support and offers guidance to ELD providers. ◾

Improving On-Time Performance with Better Flight Delay Reporting

Airlines want to get passengers to and from their destinations on time. But unforeseen problems can arise, such as bad weather, air traffic delays, and mechanical issues. That's why FAA prioritized upgrading its official system for reporting flight delay data. A new system in development will expand and improve data collection and recording.

Volpe Center aviation systems engineering experts partnered with FAA to conduct a proof-of-concept for the new system.

Volpe Center experts validated the technical feasibility of requirements, mitigated technical risks, identified different approaches in delay metrics and reporting structures, validated data integrity, and identified benefits.

Volpe experts also developed software and procured hardware, reviewed documentation for FAA streaming data services, and developed algorithms to match the same flight within and across different data services. By demonstrating the use of cost-effective, cutting-edge technologies, Volpe is laying the groundwork for the future of quality flight delay data. ◾

Analysis and Collection

Developing New Test Procedures for Vehicle Safety Applications

Vehicle safety applications are becoming standard issue on more and more vehicles in the U.S. Two emerging safety applications are intersection movement assist (IMA) and left-turn assist (LTA), both of which identify and warn drivers of potential crossing-path collisions at intersections.

More than 10,000 traffic fatalities happened at intersections in the U.S. in 2016, about 27 percent of all U.S. road deaths.

The National Highway Traffic Safety Administration (NHTSA) turned to the Volpe Center to improve its understanding of vehicle performance and driver behavior at intersections for the development and testing of effective IMA and LTA applications, by identifying metrics and providing real-world data on how drivers navigate signalized and unsignalized intersections. ◼

Developing Characteristics of Motorcycle Crashes to Inform Crash Avoidance Research

Motorcycles make up just 0.63 percent of all vehicle-miles traveled (VMT) in the U.S. and only 3.2 percent of all registered motor vehicles—but they account for more than 14 percent of annual traffic fatalities. Significantly reducing motorcycle crashes would greatly improve overall roadway safety.

Understanding the motorcycle crash problem is a critical first step in identifying potential strategies and mitigation techniques that can increase the safety of motorcycle operators and other road users.

NHTSA requested that the Volpe Center define the characteristics of motorcycle crashes in order to inform and guide motorcycle crash avoidance research and technology development.

Volpe's team evaluated five years of crash data and identified over 507,000 motorcycle crashes, including 23,245 fatal crashes during the five-year period. These crashes were classified against a complex set of criteria, including 36 possible pre-crash scenarios, and crash contributing factors such as obstructions, road conditions, and driver impairment. Volpe experts identified 11 common motorcycle pre-crash scenarios that account for 70 percent of motorcycle crashes and 81 percent of fatal motorcycle crashes.

By identifying the predominant pre-crash scenarios—and developing reliable metrics to predict vehicle paths and assess crash potential—researchers, technology developers, and vehicle manufacturers can focus on crash mitigation efforts and innovative technology applications. ◼

To Reduce Fatal Motorcycle Crashes, Understand How They Are Different

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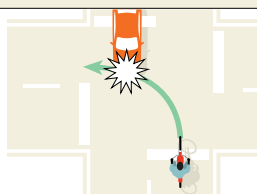
U.S. MOTORCYCLES ACCOUNT FOR

0.63% of all VEHICLE-MILES TRAVELED

3.2% of all REGISTERED MOTOR VEHICLES

14% of annual FATAL CRASHES

Making Flying More Efficient—Without Compromising Safety—through Smart Aircraft Wake Separations

An aircraft in flight leaves a swirling wake of air behind it, which may be hazardous to following aircraft if not accounted for operationally. But the national airspace system can be even more efficient if aircraft can safely fly closer together. The Volpe Center supports FAA in collecting and analyzing data to identify opportunities to safely revise wake separations of aircraft currently in service, and to set wake separation minima for new aircraft prior to entry-into-service.

Volpe experts collect and maintain wake turbulence data, meteorological and surveillance data, and data on aircraft performance and physical characteristics.

Volpe analyzes this data to determine safe wake separations between aircraft. In the past year, the Volpe Center enlarged and improved this critical database. Volpe also supported FAA in developing a methodology that standardizes and streamlines the analysis needed to set wake separations for new aircraft. ◾

Modernizing the Nation's Primary Vehicle Defects Database

To ensure safety on the nation's roads and to improve accountability to drivers, consumers, and manufacturers, data experts from NHTSA and the Volpe Center are modernizing the Artemis vehicle defects suite of applications to make it easier for investigators to flag potential risks to the driving public.

Artemis is the primary data system that the NHTSA Office of Defects Investigation uses to identify and address potential safety defects in motor vehicles.

Volpe has implemented several technical proofs-of-concepts to validate the architecture and design of the modernized system in the Amazon cloud.

The modernized Artemis will consolidate several disparate data sources, which will let NHTSA investigators immediately see important safety-related information. The Amazon cloud implementation will significantly reduce the cost and effort associated with maintaining the legacy system. ◾

Optimizing Transit Performance Management for the National Park Service

National Park Service (NPS) transit systems are as varied as the parks themselves and include ferries, shuttles, airplanes, and trolleys. System data allows NPS to communicate the impact and importance of transit within national parks.

The first NPS Transit Inventory and Performance Report was completed six years ago, and is updated annually. The Volpe Center helps initiate the transit inventory and continuously improves the data collection effort. Volpe staff collect park-level data on NPS annual operating statistics and vehicle information, complete quality control and assurance on the data, and translate the data into final reports. This data helps NPS holistically understand its transit systems. ◾

(Photo: U.S. NPS)   2 / 19