OUR NEW MOBILITY FUTURE

A U.S. DOT VOLPE CENTER
THOUGHT LEADERSHIP SERIES

FINAL REPORT

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U.S. Department of Transportation

50 YEARS | Volpe Center
1970 – 2020
TRANSPORTATION INNOVATION
FOR THE PUBLIC GOOD

OUR NEW MOBILITY FUTURE

WHAT'S INSIDE

AT THE U.S. DOT VOLPE CENTER, THOUGHT LEADERS FROM ACROSS THE GLOBAL TRANSPORTATION ENTEPRISE CONVENE TO DISCUSS FUTURE TRANSPORTATION CHALLENGES, GENERATE FRESH APPROACHES TO EMERGING ISSUES, ANTICIPATE TRENDS, AND INFORM DECISION MAKING.

Our New Mobility Future, held from May to September 2019, convened distinguished experts in transportation entrepreneurialism, design, policy, and data science who are transforming novel transportation modes to explore the promise and pitfalls of our new mobility future—and to discuss how we're going to get there.

The themes these speakers discussed cut across each of the U.S. DOT's strategic priority areas: safety, infrastructure, innovation, and accountability.

Speakers brought their bold visions for the transportation systems of tomorrow, from autonomous cars that integrate an individual's tolerance for risk, to travel by rented bike or scooter, to flying taxis.

They challenged transportation professionals to think critically about the benefits of being able to pay a fee for speedier travel access; designing policy based on data while ensuring data privacy; road vehicle innovations to save time, fuel, and lives; making sure intelligent transportation benefits all users; and a trip using multiple public and private transportation services conveniently made with a single payment.

And, they presented the notion that even the Nation's military benefits from commercial transportation services and innovations. This publication recaps the highlights of the thought leadership series. Video highlights are posted at www.volpe.dot.gov.

ADVANCING SAFETY IN OUR NEW MOBILITY FUTURE

DIANA FURCHTGOTT-ROTH
DEPUTY ASSISTANT SECRETARY FOR RESEARCH AND TECHNOLOGY
U.S. DEPARTMENT OF TRANSPORTATION
MAY 22, 2019

U.S. DOT's Deputy Assistant Secretary for Research and Technology Diana Furchtgott-Roth recently kicked off the U.S. DOT Volpe Center's 2019 thought leadership series on Our New Mobility Future.

She spoke on the benefits of enhanced mobility, improved infrastructure, and vigilant attention to safety. "We are all interested in mobility. More trips are better. We want more travel for work, we want more travel for vacation, more travel for pleasure… We want this done in a faster, cheaper, way. More trips mean that more people are better off," said Furchtgott-Roth.

INCREASED TRANSPORTATION AVAILABILITY

Furchtgott-Roth touted the benefits of having the technology available to enable people to buy the transportation that more effectively meets their needs. These gains range from existing technologies such as automated toll collection that do not require cars to slow down, to long-term prospects such as autonomous vehicles enabling individuals to work during their commute.

"These are not Lexus lanes, but Toyota lanes: lanes that enable a middle- or low-income parent to avoid a $50 fine for being late to pick up a child at daycare," Furchtgott-Roth said. "Being able to charge for transportation services—

which we were not able to do before—enables funds to be channeled into transportation improvements to the benefit of travelers."

These technologies fulfill their potential to revolutionize travel, and promise to greatly increase everyday mobility for important populations, such as traditionally underserved communities, people with disabilities and older adults, she said.

CONTINUED TRANSPORTATION SAFETY AND THE 5.9 GHZ SPECTRUM

U.S. DOT is working to usher in a new era of transportation innovation and safety. "As we prepare for the future of new, emerging technologies, such as truck platooning, where trucks can follow one another without drivers, one of the top Department priorities is to make sure we address public concerns about safety, security, and privacy, without hampering innovation," Furchtgott-Roth said. "Growing freight and e-commerce means more trucks and deliveries. Imagine a future where truck deliveries and goods delivery are increasingly autonomous and the people we work to keep safe will increasingly be people outside the vehicle." Featured transportation safety examples included pedestrian automatic emergency braking systems, and lateral protective devices on trucks. "As the population of vulnerable road users continues to evolve, research-backed, cost-effective safety transportation technologies are more important than ever."

In 1999, the FCC allocated a band in the 5.9 GHz spectrum to traffic safety and intelligent transportation systems. This valuable asset has been sought by unlicensed users. "We emphasize the importance of keeping the 5.9 GHz band for traffic safety," said Furchtgott-Roth. "Increasing connectivity in our transportation systems using the 5.9 GHz band of spectrum will increase safety and reduce the 37,000 fatalities and 2.7 million injuries on our roads every year.

> "We are all interested in mobility. More trips are better. We want more travel for work, we want more travel for vacation, more travel for pleasure… We want this done in a faster, cheaper way. More trips mean that more people are better off."
>
> Diana Furchtgott-Roth

Above: Anne D. Aylward, Director of the U.S. DOT Volpe Center, welcomes the transportation community to the 2019 series on Our New Mobility Future.

AUTONOMOUS VEHICLES THAT INCLUDE RISK IN THEIR DECISION MAKING

BRIAN C. WILLIAMS, PHD
BISPLINGHOFF PROFESSOR OF AERONAUTICS AND ASTRONAUTICS
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
JUNE 13, 2019

The promise of transportation automation seems to become more and more fulfilled each day. Today's automobiles that keep themselves in their lanes and maintain safe speeds and distances—even in stop-and-go traffic—have recently been joined by successful tests of flying delivery drones. However, increasing automation levels eventually require a vehicle to be able to not only control its own maneuvering and detect other vehicles and obstacles, but also to predict what other vehicles could be expected to do, and plan and react to other vehicles' unexpected maneuvering.

Professor Brian Williams, MIT's Bisplinghoff professor of aeronautics and astronautics, researches "model-based autonomy," or the creation of long-lived autonomous systems that are able to explore, command, and diagnose and repair themselves using fast, online reasoning. Prof. Williams' focus is on risk-aware systems whose actions operate within user-specified risk tolerances.

SAFE AND SIMPLE TRANSPORTATION AUTOMATION

Dr. Williams indicated that there are "two issues that have been central for us, which are being able to provide

systems that are assisting you… and the issue of safety—and often we end up making decisions which are a bit too risky. We need to make these systems to be safer… and we still want them to be simpler to work with." This can be enabled by artificial intelligence (AI) systems that help at tasks and are collaborative, easy to understand, aware of risks, proactive, and efficient. His work includes allowing the AI system to consider a certain level of risk, which can be set based on the user, to allow for more human-like responses in an AI-controlled vehicle.

A FLYING CAR FOR EVERYONE

One demonstration of planning and risk acceptance can be seen in his notional flying-car controller known as personal transportation system, or PTS. The PTS flying car verbally interacts with its passenger by maintaining a collaborative dialogue. It also manages risk taking, monitors for circumvented goals and activities, and creates and selects alternative backup flight plans. This interactive system is one way in which humans and robots can intuitively work to refine goals and cooperate on tasks.

SUPPORTING AUTOMATED AUTOMOBILES WITH PLANNING AND RAPID DECISION MAKING

Two other projects provide automation tools for planning (strategic) and reacting (tactical) operations for automobiles. "You want autonomous systems both to be able to understand the intention and the likely behavior of the cars around you and you also want to be able to behave in the style that is appropriate to that area," Williams said, "Our problem is that we want to make driving both less stressful and safer." The car then becomes responsible for safe maneuvering, but within the context of its environment and the situation. Williams' tactical tool predicts possible trajectories for each surrounding vehicle based on that vehicle's prior maneuver sequences, then determines likelihoods for each, and ultimately determines its own maneuvering based upon these and within the user-defined risk tolerance. The system also keeps an alternative backup plan, which it continuously updates.

These methods of guiding autonomous systems in terms of goals, and enabling multi-robot and human-robot collaboration could someday allow for vehicles that are autonomous and safe, but also, with the introduction of user-configured risk settings, perform and respond in much the same, familiar way in which we would operate them.

> "Two issues that have been central for us, which are being able to provide systems that are assisting you… and the issue of safety… often we end up making decisions which are a bit too risky. We need to make these systems to be safer… and we still want them to be simpler to work with."
>
> Brian C. Williams, PhD

BEYOND BIG DATA TO USEFUL DATA

LAURA SCHEWEL
FOUNDER AND CHIEF EXECUTIVE OFFICER
STREETLIGHT DATA
JUNE 25, 2019

"How do we turn this convergence of buzzwords into something really concrete and useful and go beyond the hype?" asked Laura Schewel, founder and chief executive officer of StreetLight Data.

MAKING THE DATA WE HAVE ACTIONABLE

StreetLight Data describes data as just a cost—until it is put to work. To add value, the data needs to be properly and intuitively analyzed in order to turn it into actionable analytics. Schewel explained that it is hard to make policy with just data.

"All of this data is out there, but that is not useful big data. You can't make a policy about that road based on that data… you have to turn that data into something useful," Schewel said. "It is imperative that we adopt a stance of having persistent, independent impact metrics as new mobility [service-based transportation business models including mobility on demand, mobility as a service, and shared mobility] hits the roads, and that means impact on congestion, on accessibility, on climate, on jobs, everything."

FINDING MOBILITY DATA ON PEDESTRIANS

Getting large volumes of detailed data from automobiles can be straightforward, given the number of contemporary cars with built-in navigation systems and network connectivity, as well as similar systems in use on drivers'

phones, Schewel said. But what about for pedestrians, cyclists, scooters, and so on?

"Almost every human in America has put a mobile sensing device into their pocket," she said.

With that insight, cell phones using opt-in tracking apps became an additional source of their transportation data set, she said. At this time, they see 60 to 70 million phones in the United States and Canada in addition to connected cars and trucks; pedestrian and other data is now known and available for analysis and decision making.

CONTINUING DATA CHALLENGES

Additional remaining challenges include the serious consideration of privacy—even with anonymized movements—and basic road and other transportation maintenance.

"It's critical for the industry that we all take a very rigorous approach to data privacy because this data is extremely powerful," Schewel said, emphasizing that one cannot be too cavalier about raw, individualized travel data.

"Big data is powerful, and anything powerful can do some really amazingly good stuff for society and can do some not so good stuff… we have to balance those concerns," she said.

Ironically, her most desired high-tech item is hardly a technology at all and is something that all road users—not just computers—can benefit from: road maintenance. Due to the ability of road maintenance to make the job of driving easier and safer for automated vehicles as well as for human drivers, pedestrians, and cyclists, Schewel declared that, "The most important new mobile technology that we all need to work on is paint."

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>
> Laura Schewel

AUTOMATED, CONNECTED, ELECTRIC, AND SHARED (ACES) VEHICLES AND THE FUTURE OF DRIVING

BRYAN MISTELE
CO-FOUNDER, PRESIDENT, AND CEO
INRIX
JULY 9, 2019

The advent of mass-produced, relatively low-cost automobiles by Henry Ford and his manufacturing advances revolutionized how we get from place to place and how we live day to day. For the first time in a century, Bryan Mistele, president and CEO of INRIX, sees a similar transformation coming. "Fundamentally the idea of a human being buying a car that had four wheels [and] an internal combustion engine really didn't change for 100 years," Mistele said. "Think about how much has changed just in the last 10 or 15 years. Ten or 15 years ago… there was no Tesla, there was no iPhone, there was no iPad."

GROUND TRANSPORTATION CHALLENGES

Mistele describes three numbers that underscore the key challenges in ground transportation: eight billion, 1.2 billion, and 37,000. "Eight billion, that's the amount of hours wasted in congestion in the United States every year—not total drive time for commuters—the incremental amount of time wasted in congestion," he said. While his first number indicates wasted time, 1.2 billion shows the wasted fuel due to congestion and 37,000 represents the annual fatalities on U.S. roads. "What we're talking about are real, core, societal problems," Mistele said. "We're talking

a massive, global, societal problem with big ramifications." Significantly, four recent developments may be able to address these in dramatic fashion.

THE HOPE OF RECENT VEHICLE-RELATED BUSINESS MODELS AND TECHNOLOGIES

Complementary advances in the last decade or so may be positioning the ground transportation industry at an inflection point: autonomous vehicles of varying levels up to level 5 or full automation (i.e., self-driving), connected vehicles (i.e., vehicles that broadcast information about their movements), electric-powered vehicles, and ride sharing—the ACES. "All these trends have happened in the last 10 years," Mistele said. "These are not independent trends; there is a reason that they're all happening at the same time." Mistele then described the automobile industry's vision in which, initially, these vehicles would be delivered as fleets rather than individually owned.

THE POTENTIAL FOR SAFETY AND EFFICIENCY GAINS WITH THE ADVENT OF ADVANCED AND SHARED VEHICLES

With the latest luxury sedan having 200 times more lines of computer software than the space shuttle, Mistele recognizes that "the car has become a mobile computing platform." In addition, the volume of data being generated is tremendous. "What we're talking about here is about 4,000 movies worth of information being generated every day by an autonomous vehicle," Mistele said. This data, along with other ACES advances, may help to address the key challenges associated with ground transportation.

Autonomous technologies should be able to reduce congestion: as cars no longer need to park, those parking areas can be used as additional lanes. Autonomous vehicles will also provide accessibility regardless of a person's age or disability. According to Mistele, a wide range of physical abilities and age groups will now "have the ability to take part in transportation where they wouldn't be able to do that before."

Connected technologies, including their associated vehicle sensors, show potential for considerably increasing safety for their occupants, other vehicles, and vulnerable road users, including pedestrians and cyclists. Electric propulsion technologies allow for more environmentally friendly transportation, Mistele noted: "The key is of course the grid and making sure that the grid is clean, but as more and more vehicles go electric, you see a pretty big impact. In fact, in Beijing, where pollution is a huge issue… most vehicles [shipped there] are electrified." Finally, ride-sharing technologies can show multiple benefits with reductions in congestion, pollution, cost, and space while increasing safety (in the case of impaired drivers) and convenience.

The promise of ACES may mark the turning point for the next hundred years, with today's Henry Fords marshaling technological prowess, rather than manufacturing prowess.

> "What we're talking about here is about 4,000 movies worth of information being generated every day by an autonomous vehicle."
>
> Bryan Mistele

AIRBORNE RIDE SHARING

J. SCOTT DRENNAN
VICE PRESIDENT OF INNOVATION
BELL
JULY 23, 2019

When a version of the Taylor Aerocar was featured in a 1974 James Bond film, flying cars seemed just around the corner; however, with just six built from 1949 to 1960, it was ahead of its time. According to Vice President of Innovation for Bell J. Scott Drennan, current trends in society and progress in technology may harbor the long-awaited future of personal air transportation.

CONVERGING DEVELOPMENTS

Drennan identified three converging trends in society: "We know that urbanization is taking place all across the world, more people are moving to urban centers and choosing to live in urban environments; we know about the shared economy, we hear about folks taking shared rides,… sharing cars; [and we know about] instant gratification… dial it up… and it can be at the house in two hours."

In addition to the convergence of urbanization, the shared economy, and instant gratification, technological progress is coming of age as well, with Drennan listing autonomy, artificial intelligence, and electric, hybrid, and distributed propulsion as driving factors.

Recent studies also predict the rapid growth of urban air mobility and air taxis. Drennan cites forecasts showing that 15 major U.S. cities are expected to be conducting 750 million passenger trips per year by 2030, and that the number of passenger drones will need to climb from between 900 and 1,500 units globally in 2025 to between 9,000 and 12,000 by 2035.

TECHNOLOGY IS NOT THE CHALLENGE

"Technology is the easy part," Drennan said, listing the biggest challenge as being the operational component, followed by certification, then manufacturing, and finally technology. The operational aspect requires the timely development of a reliable, safe, quiet, and affordable aircraft. This has been a major focus for aerial-ridesharing company Uber Elevate's five initial urban-air-mobility original-equipment manufacturers, of which Bell is one. Certification entails getting the aircraft approved for airborne use by a range of diverse international regulators. Manufacturing requires building relatively high volumes of the aircraft.

Drennan elaborated, saying, "This would be a scenario where we'd have to build thousands of these types of vehicles per year rather than today's state, [where] if we build 300 everybody's popping champagne bottles and celebrating, so [it's] a very transformational-type projection there from NASA and their partners." Finally, technology includes the ability for autonomous operation of the aircraft, which could range from having a pilot onboard to monitor the flight, to a remote pilot that is monitoring many air taxis, to operation with little or no human intervention or monitoring.

Drennan presented a compelling photograph illustrating the historical speed of past transportation revolutions. "In 1900 [on] Fifth Avenue, [there is] one car, the rest [are] horse and buggies," he said, "and then 13 years later, one horse and buggy, the rest [are] cars." In viewing this, it seems plausible that our near future just may include the long-awaited promise of being able to travel from point to point via the air—traveling like a character from a Bond movie may no longer be that far off.

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>
> J. Scott Drennan

SMALL SCOOTERS AND BIG DATA

REGINA CLEWLOW, PHD
CEO AND CO-FOUNDER
POPULUS
JULY 30, 2019

Micromobility—small, lightweight modes of personal transportation such as scooters and bikes—and their associated data are being used to transform how individuals travel and how cities plan, according to Regina Clewlow, PhD, the CEO and co-founder of micromobility data company Populus.

"We've really transitioned from mobility as a product that one buys, typically a car, to mobility as a service, and this is in large part due to the proliferation of these shared business models and the arrival of dockless bikes and scooters," she said.

SHORT TRIPS AND THE NEW MOBILITY

With 45 percent of trips in the U.S. being three miles or less and 78 percent of those being made by car, micromobility is an opportunity to reclaim streets, stated Clewlow. She cited the rapid adoption of new mobility services resulting from a spike in smartphones, more inner-city congestion, and an infusion of venture capital into micromobility companies.

Half of the people in the San Francisco Bay area regularly use Uber and Lyft and, of these, 2 out of 10 of them do not own a car, have gotten rid of a car, or have postponed buying a car, Clewlow said. In seven major metropolitan areas, three out of five Uber and Lyft trips would have otherwise been made by walking, biking, or public transit, or would not have been made at all.

She also cited how cities and public agencies were taken off guard as the introduction of electric scooters has more than doubled the number of micromobility trips in the

U.S., from 35 million to 85 million, in just one year. In many major cities, it is just faster to bike or scooter for trips that are three miles or less.

CITIES AND DATA

"GPS-enabled smartphones are now in the hands of basically everyone," Clewlow noted.

With smartphone adoption rising from 35 percent in 2011 to 77 percent in 2018, a large volume of transportation data, including micromobility data, is now available, she said. Furthermore, cities are now able to request very detailed trip data from private operators in standardized formats. These public agencies use the data from private mobility operators to manage their progress towards public goals, including the reduction of transportation-related injuries and fatalities, improving the availability and accessibility of transportation services, prioritizing the efficient use of public space, and reducing transportation energy use and its accompanying climate impact.

As an example, Clewlow described how cities could use aggregated volumes from millions of scooter trips to identify new protected lanes.

"The public sector primarily has the responsibility for ensuring that these [micromobility] services are safe, that they're equitable, and that they're sustainable," she said. "[The public sector is] really the only entity that can hold private-sector mobility companies accountable."

EFFICIENCY, SAFETY, CLIMATE, AND MICROMOBILITY

Shared electric scooters have become a model for public-agency management of private-sector mobility companies.

"Cities are now viewing scooters as a testing ground for managing all things that move… and many cities are now requiring access to real-time data in addition to historic data… from shared bikes [and] scooters for the purposes of monitoring compliance with policies, such as vehicle fleet caps… as well as to harness this new information for long-range planning," Clewlow said.

As a result, public agencies have an unprecedented opportunity to re-think how they allocate—and how companies price—access to our sidewalks, streets, and curbs.

Clewlow discussed the huge number of road fatalities in the United States and the transportation sector's major contribution to greenhouse gas emissions.

"But together, I'm optimistic that we can drive the progress forward and excited how micromobility has changed the landscape," she said.

"The public sector primarily has the responsibility for ensuring that these [micromobility] services are safe, that they're equitable, and that they're sustainable; [the public sector is] really the only entity that can hold private-sector mobility companies accountable."

Regina Clewlow, PhD

GLOBALLY INTEGRATED LOGISTICS AND THE CHANGING CHARACTER OF WAR

GEN. STEPHEN R. LYONS
COMMANDER
U.S. TRANSPORTATION COMMAND
SEPTEMBER 17, 2019

"There has been a proud history between the Department of Defense (DoD) and domestic transportation, [and that] relationship has been long and steady," said General Stephen R. Lyons, the 13th commander of the United States Transportation Command (USTRANSCOM).

Transportation is such a crucial component of the U.S. military's ability to meet its global commitments that it is the sole focus of 1 of the 11 Unified Combatant Commands in DoD. USTRANSCOM is responsible for the coordination of people and transportation assets to allow the U.S. to project and sustain forces whenever, wherever, and for as long as they are needed. It provides support to the 10 other U.S. combatant commands, the military services, defense agencies, and other government organizations, and is the single manager of the U.S. global defense transportation system.

USTRANSCOM also maintains close links to civilian counterparts, including modal agencies within U.S. DOT.

VITAL LINK TO COMMERCIAL TRANSPORTATION

"There are… domestic ties to the Department of Transportation in every single sector," said General Lyons. "We interface on a regular basis to ensure that the Department of Defense and our joint force has the ability to project from the continental United States."

Though USTRANSCOM was established in 1987, the history of our military's transportation activities goes back hundreds of years and includes maritime operations in the 1700s and use of railroad transport in the 1800s.

In addition, President Dwight Eisenhower's support of the Federal-Aid Highway Act of 1956 led to the creation of the Interstate Highway System and realized Eisenhower's vision of a strategic network of highways capable of moving materiel and troops in time of war.

APPLYING TRANSPORTATION ADVANCES TO DOD CHALLENGES

"Conveyances aren't much good unless we have nodes and routes to connect them to," General Lyons said. "This network of both military enroute capabilities, as well as commercial trade routes, gives us tremendous flexibilities."

However, this connection to public infrastructure and commercial industry means that operation and ownership of ports, conveyances, and the overall supply chain makes for both a diverse, capable, and flexible asset, as well as a potential risk due to the wide range of intricate dependencies, he said.

Transportation advances can be rapidly and readily shared between the military and commercial segments.

"I see the commercial industry leading in the technology frontier when it comes to logistics and logistics innovation," General Lyons said, in terms of the commercialization of military transportation innovations. "The equities that you have on the future of industry are the same equities I have: to make sure that we have a viable, vibrant industry in the aviation world, in the sealift world, railways, et cetera."

CHANGE IS CONSTANT

"The character of war and the character of logistics that has to keep pace with operations is changing dramatically," General Lyons said. "The purpose of why we exist is what doesn't change."

As DoD works to project and sustain combat power on a global scale, threats such as contested lines of communication and advanced weaponry join a growing list of drivers of the DoD logistics value chain.

Weapon system advances, such as those with a reduced logistics footprint, combined with technological progress in other fields such as automation and outer space, present opportunities for USTRANSCOM.

"Space is in everything that we do, whether it's sensing [or] communications," General Lyons said. "And it's also becoming more contested and congested."

Automation is already playing a significant role in the military, and USTRANSCOM's project portfolio includes unmanned aerial tankers for refueling aircraft in flight.

General Lyons also pointed out some current cautions related to automation and artificial intelligence.

"There are some challenges," General Lyons said, "not just in terms of culture, but in terms of what happens if everything doesn't go exactly as the algorithm said it was going to go—how do we respond to that?"

He also explained that much of the military's core mission will not be done by machines alone.

"Anytime you're talking about warfare… it's inherently a human activity and will always be a human activity by its fundamental nature," he said.

The longstanding ties between DoD and transportation will continue steadily into the future.

"Much of our mobility infrastructure today has been shaped by the need for national security and to move our forces," said General Lyons. "We recognize that the security environment is changing quite rapidly, [and] we're inextricably linked to… the viability of a commercial industry that we can rely on for national security needs in the future."

"Much of our mobility infrastructure today has been shaped by the need for national security and to move our forces. We recognize that the security environment is changing quite rapidly, [and] we're inextricably linked to… the viability of a commercial industry that we can rely on for national security needs in the future."

Gen. Stephen R. Lyons

MAKING SURE INTELLIGENT TRANSPORTATION GETS EVERYONE THERE

SARAH KAUFMAN
ASSOCIATE DIRECTOR
NEW YORK UNIVERSITY RUDIN CENTER FOR TRANSPORTATION POLICY AND MANAGEMENT
SEPTEMBER 19, 2019

Personal transportation is a major part of daily life for many Americans. Progress in different areas of intelligent transportation can make trips lower in cost, faster, and more convenient. However, research at the Rudin Center indicates that making mobility more inclusive is key to intelligent transportation.

"Urban planning is becoming more intelligent every day… through collection and data analysis, better infrastructure, more precise planning, and other means; however, mobility is only becoming intelligent for a portion of the population," according to Rudin Center Associate Director Sarah Kaufman. "Several groups are being left behind, including lower-income residents, women, people with different forms of disabilities, and a variety of residents who are not currently represented," she said.

LOCATION, LOCATION, LOCATION

One recent Rudin Center study analyzed transit access and job opportunities, ranking New York City's (NYC) 177 neighborhoods by the number of jobs accessible within one hour on transit. About one-third of residents experienced disparate impacts on salaries and job opportunities.

"They faced long commutes, often with transfers," Kaufman said. "This takes a toll on household earnings... and even

more so in unemployment rates. Access to jobs by transit is vital. The more jobs you can access, the more likely you are to earn a new, higher-paying job, or at least reduce your period of unemployment."

Kaufman argues that we must make transit smarter, more efficient, and dynamic. For example, lower-income households—often hourly workers—tend to travel at different rush hours than white-collar workers, according to a study by the NYC Comptroller. They tend to have access only to off-peak services (such as local, versus express, services with their associated long headways) that prolong their commutes. "That cuts into hourly wages especially," said Kaufman. "Now that we have… 21st-century data collection to plan around the revised rush hour, it's essential that we serve these hourly workers as well."

URBAN TRANSPORTATION'S UNSEEN PINK TAX

Other research at the Rudin Center found that not all populations experience transportation equally. One example is its finding of a "pink tax" on public transportation. The term refers to the additional amount women may be charged for products or services, and according to the NYC Department of Consumer Affairs, this is typically about seven percent. Rudin Center researchers sought to determine if the pink tax applied to transportation, not in higher prices for the same subway ride, but in additional costs incurred to ensure an efficient and safe ride. Three-fourths of female survey respondents experienced some form of risk to their personal safety while on public transportation.

"That's a bleak picture, but it got worse," Kaufman warned. "A lot of women remarked that they couldn't even count the number of times they had been harassed on transportation." Most incidents in the survey had occurred within the subway trains during rush hour. "As a result of these real and perceived safety concerns, women change their behaviors," she said. "Women in the survey reported changing their dress… and, people who can afford to, avoid public transportation, especially late at night." Many of the women surveyed indicated that they feel safest late at night in a for-hire vehicle, though as Kaufman pointed out, those modes have seen documented, disconcerting safety issues as well.

So how much does changing modes solely for the purpose of safety cost women? "They reported between $26 and $50 per month on top of their regular monthly transportation costs," Kaufman said. Men did not report any added cost. While the findings were sobering, the reaction to the information generated by the Rudin Center has been positive. "I do want to point out that the pink-tax work has struck a nerve," Kaufman said. Follow-on studies are planned across the U.S.—including Denver, Seattle, and Los Angeles—as well as in several international cities. "The challenges of women and femme-presenting individuals… should not be underestimated when we devise new stations and when we develop new technologies," she advised.

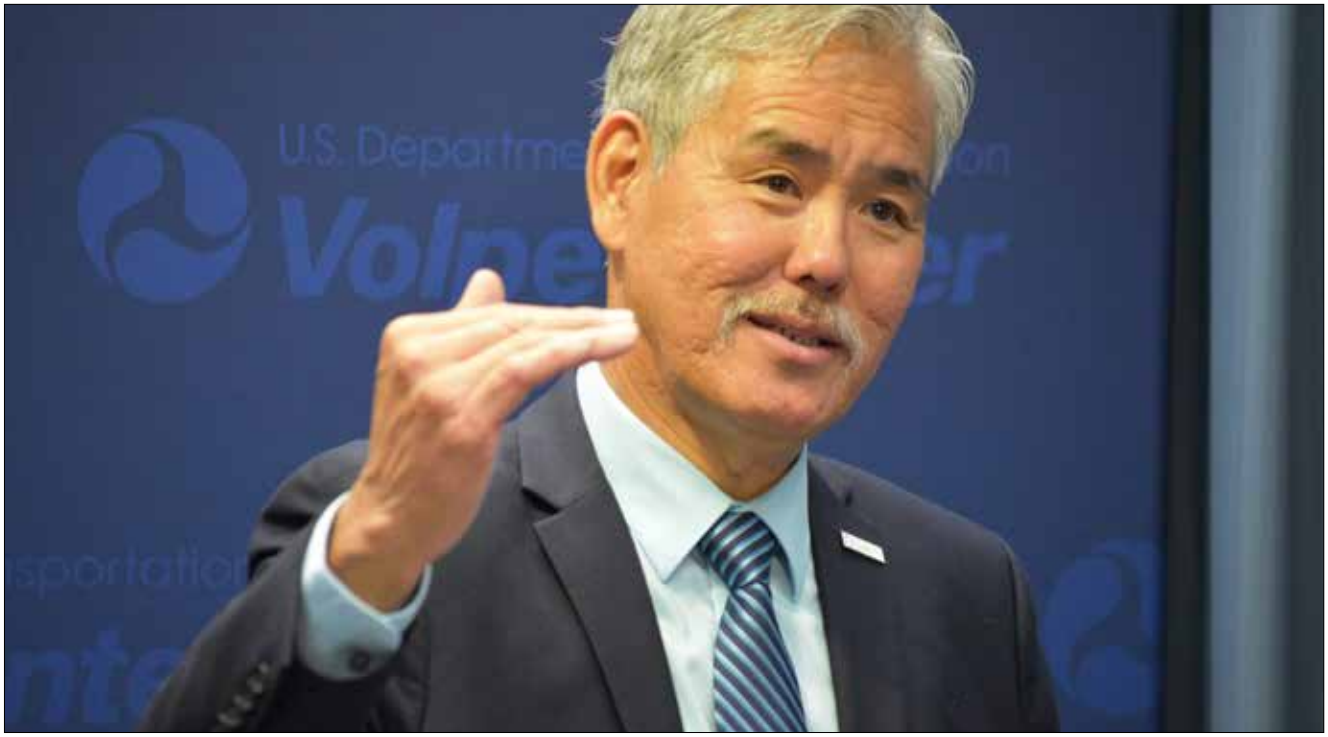
A MORE INCLUSIVE TRANSPORTATION SYSTEM

Kaufman believes inclusion is the key to successfully implementing intelligent transportation systems, and she offers three essential components. First, ensure the availability of a safe, reliable, and efficient transit system. Secondly, Kaufman explained that "data is the new oil," adding, "Transportation is becoming increasingly data driven." However, she cautions that it is critical to know who has access to the data and what they are doing with it. Lastly, the transportation service providers should listen to the insights and concerns of their riders, which is becoming more and more practical with the proliferation of social media.

"Intelligent transportation [relies on] five key elements: reliability, data, safety, communications, and diversity," Kaufman summarized. "And—as we add intelligence to maximize our vehicle, driver, and passenger throughput—we have to keep in mind the experience. Are people safe, comfortable, and accommodated?"

"Intelligent transportation [relies on] five key elements: reliability, data, safety, communications, and diversity, and—as we add intelligence to maximize our vehicle, driver, and passenger throughput—we have to keep in mind the experience. Are people safe, comfortable, and accommodated?"

Sarah Kaufman



A GOVERNMENT ROLE MODEL FOR TRANSPORTATION

RANDELL H. IWASAKI
EXECUTIVE DIRECTOR
CONTRA COSTA TRANSPORTATION AUTHORITY
SEPTEMBER 25, 2019

Just east of San Francisco, Contra Costa County boasts a large, active, and innovative transportation agency.

Voters established Contra Costa Transportation Authority (CCTA) in 1988 to manage the county's transportation sales tax program. CCTA is responsible for maintaining and improving its county's transportation system and overseeing its transportation infrastructure projects; however, it is the agency's integration of innovative technologies and policies that has made it a benchmark in the transportation public sector. Randell Iwasaki is the executive director of the CCTA.

TESTING THE SAFE INTEGRATION OF AUTONOMOUS VEHICLES

Autonomous vehicles promise to make for safer roads, less congestion, better air quality, and increased accessibility and opportunity. CCTA is making use of these vehicles in a pair of experiments serving its aging population and wheelchair users.

CCTA is also one of eight applicants in seven states to be awarded grant funding from U.S. DOT in September 2019 to test the safe integration of automated driving systems (ADS) on our nation's roadways. CCTA will demonstrate

Level 3 and Level 4 automated vehicles using shared on-demand, wheelchair accessible ADS-equipped vehicles.

By 2035, 30 percent of the population is expected to be age 65 or older, and new and alternative transportation solutions are needed to support this aging population. CCTA's ADS demonstration projects seek to advance the safety of ADS and facilitate data collection in order to support rule making and safety-performance standards, provide a range of mobility choices to transportation-challenged and underserved communities, and expand shared mobility options.

At Rossmoor, a gated assisted-living community in Walnut Creek, California, first mile/last mile shared autonomous vehicles are being tested in order to increase transit accessibility for the elderly on the community's private roads.

"The idea is to put an on-demand shuttle system and then make a handoff," Iwasaki said. "We want to bring that transit service and make a connection that's protected."

In Martinez, California, county-hospital-accessible transportation includes an innovative on-demand, wheelchair accessible, autonomous vehicle shuttle service. By providing accessible transportation to the local public health facility, it achieves two goals: quality of life for participants is improved and medical appointment absenteeism is decreased.

CREATING INTEGRATED, END-TO-END JOURNEYS

Iwasaki sees mobility as a service (MaaS) as being a combination of public and private transportation services that aim to optimize the transportation system while providing personalized mobility options based on traveler needs. These integrated, end-to-end journeys can then be conveniently paid for by the traveler with a single payment.

CCTA has set a goal of a 10 percent shift from solo drivers to shared mobility, with this marginal mode shift resulting in a measurable reduction in congestion.

"You want to get people into transit and then make the connections to modes. If you don't do that, you're going to drive," Iwasaki said. "Once you get in your car, you're staying in your car—that's just the way it is."

Promoting shared mobility may not be as daunting as it might seem. A new generation is shifting away from car ownership and moving to other modes of transportation because of increased convenience, environmental awareness, and the costs of car ownership and maintenance. As a result, fewer people are obtaining driver's licenses and are relying more on other modes of transportation. The costs of shared mobility and other modes of transportation are now readily competing with car ownership.

One mechanism for achieving shared mobility is the prototype Bay Area MaaS platform that uses software applications and transportation assets to harness existing mobility options. It is also flexible enough to add new mobility options, payment options, and meaningful local rewards and incentives. The platform integrates efforts in the San Francisco Bay Area and provides a scalable, phased approach to implementing MaaS.

"[Right now] you can't just go from one point to the other point and everything's taken care of," Iwasaki said. "So we want uniform payment."

The vision for the mobile application is for the user to enter an origin and destination, and then the application will provide a suite of mobility options to meet the user's needs, at which point the user can schedule and reserve the transportation modes, pay, track their journey, and receive incentive rewards.

"You want to get people into transit and then make the connections to modes. If you don't do that, you're going to drive. Once you get in your car, you're staying in your car—that's just the way it is."

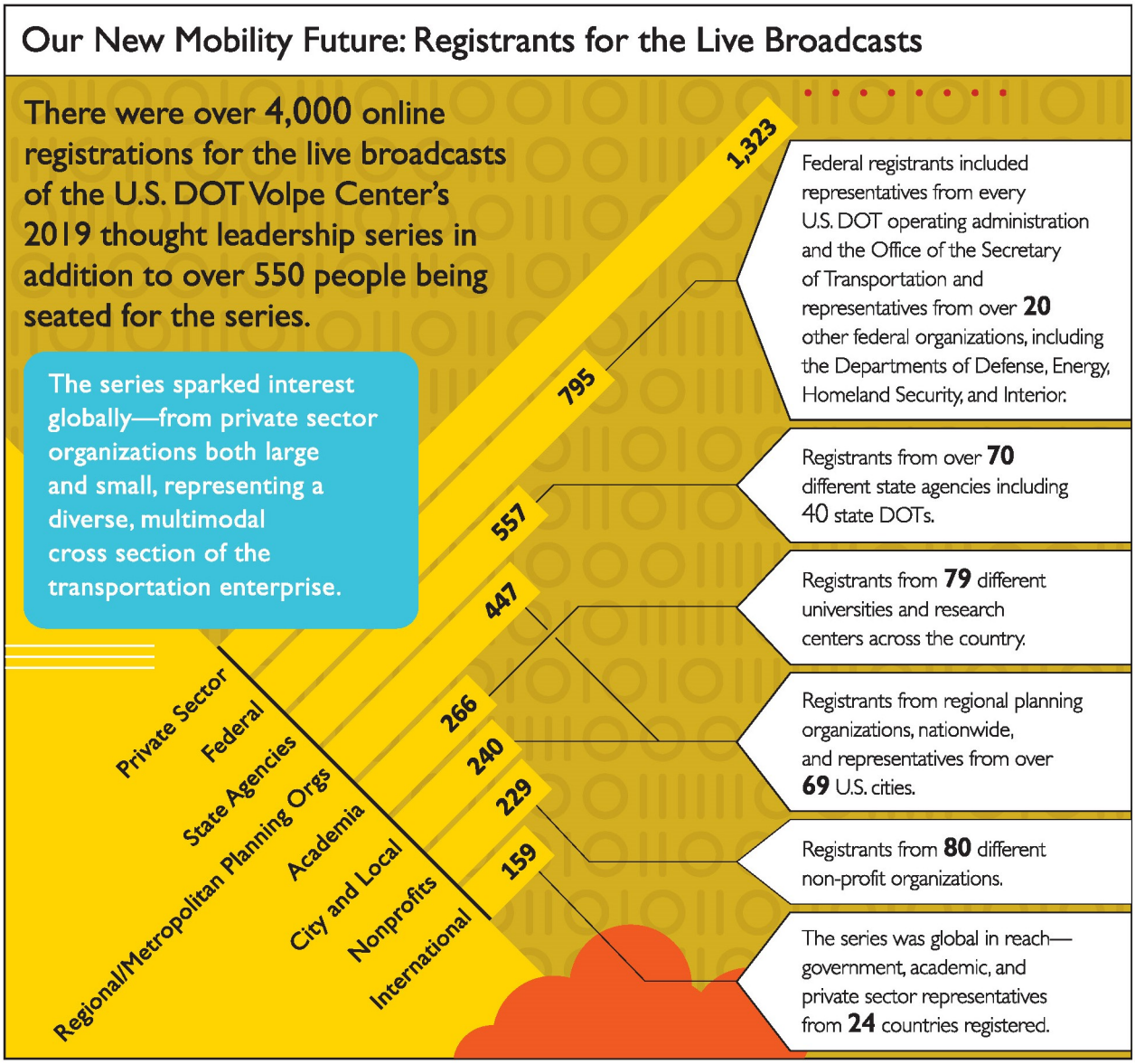
Randell H. Iwasaki

ENGAGING THE TRANSPORTATION ENTERPRISE

Through its thought leadership program, the U.S. DOT's Volpe Center is engaging a broad range of stakeholders in an important dialogue about emerging and future transportation issues. The Our New Mobility Future series continued to engage representatives from government, academia, non-profit organizations and the private sector in important conversations that inform decision making and help shape the future of transportation.

Those attending in person and those watching the live broadcasts had the opportunity to listen to a variety of perspectives and to engage with experts during question and answer periods. The chart to the right provides data related to stakeholder engagement in the series.

We hope you'll continue to JOIN THE CONVERSATION!



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This report recaps Our New Mobility Future, a thought leadership speaker series held from May to September 2019 at the U.S. DOT Volpe Center in Kendall Square, Cambridge, MA. The series convened distinguished experts in transportation entrepreneurialism, design, policy, and data science who are transforming novel transportation modes to explore the promise and pitfalls of our new mobility future—and to discuss how we're going to get there.

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