UNIVERSITY OF MARYLAND

A NEW HUB FOR TRANSPORTATION RESEARCH, WORKFORCE DEVELOPMENT, AND TECHNOLOGY TRANSFER.

Maryland Transportation Institute

ANNUAL REPORT 2018-19

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A MESSAGE FROM THE DIRECTOR

The world of transportation is undergoing rapid, dramatic change. New technologies have the potential to make travel safer, more efficient, and friendlier to the environment. At the same time, major challenges remain—including congestion, traffic fatalities, sprawl, and the need for upgraded infrastructure. Given Maryland's role as an economic and technological hub, as well as its proximity to the nation's capital, the future of our state is intricately linked to the future of transportation.

Recognition of this crucial link helped drive the establishment of the Maryland Transportation Institute (MTI) in April 2018. MTI brings together researchers from across many different disciplines as they develop innovative solutions to address pressing transportation needs. In this annual report, the first since MTI was launched, you'll read about some of these endeavors. They include:

- Cutting-edge research on transportation big data for multimodal transportation system management and decision support
- An app that nudges travel behavior changes for congestion reduction, enabled by real-time transportation systems modeling and simulation
- Novel traffic signal designs that reduce accident risks and fatalities at intersections in urban and rural areas
- Research into the interaction of automated and human-driven vehicles
- New MTI initiatives such as Transportation and Health, New Mobility Driving Economic Development, Big Data for Safety, and Equity and Access to Opportunities

MTI experts, drawn from fields that include engineering, planning, computer science, economics and policy, business management, and public health, each bring their specialized knowledge and perspective to the shared enterprise of improving transportation—not only in Maryland, but nationally and even worldwide. They are supported in their work by some of the most advanced tools and resources available. MTI is home to the largest transportation data center in the United States, operates a National University Transportation Center designated by the U.S. Department of Transportation, and serves as the interdisciplinary hub that connects more than 20 affiliated research centers and 104 affiliated faculty across ten different colleges at the University of Maryland.

During our inaugural year, MTI has achieved important milestones. Of particular note is the selection of our first group of MTI Seed Grant recipients—six multi-college research teams engaged in projects that advance the transportation field with new data and new methods. In total, MTI is currently coordinating more than 50 active research projects and has won more than $23 million in external research funding during our first year. In addition to facilitating research, we also are helping to advance workforce development and technology transfer with respect to transportation issues. MTI sponsors a broad spectrum of certificate and degree programs, many tailored to working professionals or to students seeking graduate-level credentials.

Our initial success would not have been possible without support from university leaders who believe in the value of strategic investments in MTI; state leaders who advocate for innovative, cost-effective transportation solutions; all our research sponsors who have not only taught us real-world needs but also financially supported our faculty and student research; and the dedication of all MTI affiliates, staff, and friends. To you all, I would like to express my appreciation for helping us create and operate a dynamic organization that helps drive innovation, economic development, and improved quality of life.

Lei Zhang
DIRECTOR, MARYLAND TRANSPORTATION INSTITUTE
HERBERT RABIN DISTINGUISHED PROFESSOR
A. JAMES CLARK SCHOOL OF ENGINEERING
UNIVERSITY OF MARYLAND

STATE, UNIVERSITY OF MARYLAND OFFICIALS CELEBRATE LAUNCH OF MARYLAND TRANSPORTATION INSTITUTE

The Maryland Transportation Institute (MTI), established with the mission of fostering innovation in the transportation sector through cross-disciplinary research, received its official launch on April 3, 2018 at a kickoff ceremony at the House Office Building in Annapolis MD, with state and university leaders in attendance.

"Through its important research, this institute will help us remain one of the most innovative transportation departments in the country," said Maryland Department of Transportation Secretary **Pete K. Rahn**, who spoke at the event.

"Establishing MTI really hits the ball out of the park in terms of using transportation innovation to stimulate economic development in Maryland," said Deputy Secretary of the Maryland Department of Business and Economic Development (DBED) **Benjamin H. Wu**.

Led by University of Maryland (UMD) A. James Clark School of Engineering's Herbert Rabin Distinguished Professor **Lei Zhang**, MTI brings together experts in engineering, planning, social sciences, computer sciences, business, public policy, and public health to tackle some of today's most pressing transportation concerns through innovative technologies and research. Specific areas of focus include transportation big data, connected and automated transportation, congestion mitigation, freight and logistics, infrastructure planning and policy, transportation safety and security, smart cities and communities, and future mobility systems.

"MTI harnesses the expertise of transportation researchers across the university to generate timely, practical solutions to some of the most complex challenges of the 21st century," UMD Senior Vice President and Provost **Mary Ann Rankin** told attendees at the kickoff event. "The University of Maryland has a long and rich history of advancing knowledge in areas of critical importance to the state, the nation, and the world." UMD Vice President of Research **Laurie E. Locascio** and Dean of the A. James Clark School of Engineering **Darryll J. Pines** also addressed attendees at the event.

The institute leverages the largest transportation data and data analytics center in the nation and a U.S. Department of Transportation-designated National University Transportation Center. MTI also encompasses leading centers in smart growth, cybersecurity, GIS, logistics, sustainability, computer sciences, behavioral sciences, and public health.

"Transportation issues pervade every area of our lives and the lives of our communities," said Zhang. "MTI will work with our government, nonprofit, and industry partners toward zero traffic fatalities, infrastructure construction and maintenance cost reduction, immediately deployable congestion mitigation technologies, and advanced transportation technologies to improve quality of life and economic development in our state and beyond."

The April 3 event featured a number of transportation technology solutions, including a mobile app that helps combat congestion by providing personalized travel incentives. The Center for Advanced Transportation Technology (CATT) introduced attendees to a suite of decision-making tools backed by big data analytics.

Undergraduate students from UMD Loop presented their design for the SpaceX Hyperloop Competition, and collaborators from Morgan State University's Urban Mobility and Equity Center and the Department of Engineering and Aviation Sciences at the University of Maryland Eastern Shore shared a cutting-edge driving simulator that helps reduce traffic accidents and a workforce development program for the aviation industry, respectively.

MTI was formed through support from 10 UMD colleges and schools: College of Architecture, Planning and Preservation; School of Arts and Humanities; College of Behavioral and Social Sciences; Robert H. Smith School of Business; College of Computer, Mathematical, and Natural Sciences; A. James Clark School of Engineering; Philip Merrill College of Journalism; College of Information Studies; School of Public Health; and School of Public Policy.

MTI harnesses the expertise of transportation experts across the university community in Maryland

1999

Maryland Transportation Initiative established at UMD to promote interdisciplinary transportation research collaboration.

2002

The Center for Advanced Transportation Technology (CATT), a leader in big data and agency coordination, established with a mandate to support national, state, and local efforts to improve transportation safety and efficiency.

2007

UMD wins a US Department of Transportation (USDOT) grant to establish a Tier One University Transportation Center with a focus on integrated transportation systems management.

2013

USDOT designates UMD as the lead of a National University Transportation Center with a focus on economic competitiveness, through a national open competition.

2015

The annual research expenditure of the transportation engineering program at UMD exceeds $20 million for the first time.

2016

With funding awarded under the FAST Act, Morgan State University and University of Maryland partner to establish an Urban Mobility and Equity Center.

2017

Academic Ranking of World Universities ranks the UMD Transportation Science and Technology Program as the fourth in the United States and 11th in the world.

2018

With funding support from the FY 2018 UMD Provost's Initiative and the A. James Clark School of Engineering, Maryland Transportation Institute (MTI) is officially launched.

WHO WE ARE

Led by the University of Maryland, MTI brings together interdisciplinary transportation expertise from across Maryland universities to develop and deploy innovative solutions that address urban and rural transportation problems. Through partnerships with our government, non-profit, and private-sector collaborators, MTI helps pioneer cost-effective ways to improve safety, reduce congestion, promote sustainability, enhance equity, and preserve infrastructure. With our team of leading international experts in engineering, planning, data analytics, computer and information sciences, social sciences, business and logistics, public policy, public health, and the humanities, MTI is uniquely equipped to foster new approaches that fuel community and economic development in Maryland and beyond.

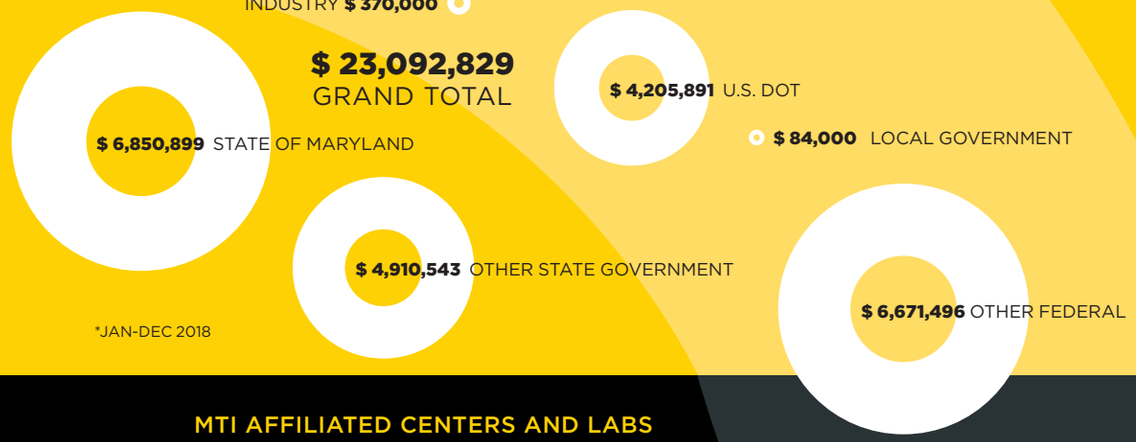
WHAT WE DO

- Big Data & Data Analytics
- Connected & Automated Transportation
- Economics & Policy
- Freight & Logistics
- Infrastructure
- Modeling & Simulation
- Planning & Environment
- Performance Monitoring & Management
- Safety & Security
- Traffic Operations & Control

BY THE NUMBERS

- Over **100** affiliated faculty from 10 UMD colleges and schools
- **20** affiliated centers and labs
- **$1 billion** annual total economic benefit to the State of Maryland
- Research projects totaling more than **$23 million** a year
- More than **10 billion** data records collected, fused, and analyzed daily by the nation's largest transportation data center
- **250** student researchers supported each year
- More than **500** transportation professionals trained annually

MTI SPONSORS: AMOUNTS AWARDED*



*JAN-DEC 2018

DATA-DRIVEN SOLUTIONS FOR ECONOMIC DEVELOPMENT

MTI centers and labs transform data into practical solutions that build a more efficient, safe, equitable, and sustainable transportation system. From visualization tools and simulation methods to dynamic ridesharing algorithms and emergency evacuation management solutions, our experts are pushing the envelope with traditional, new, and big data sources.

REGIONAL INTEGRATED TRANSPORTATION INFORMATION SYSTEM

Largest transportation data platform in the world, providing analytics and visualization tools to users in all 50 states and D.C.

MARYLAND INTEGRATED TRANSPORTATION ANALYSIS AND MODELING SYSTEM

Integrated, advanced travel demand models are combined with fine-grained, time-sensitive traffic network models to support agency goals related to planning, integrated planning and operations, and transportation systems management operations.

PROSPECTS FOR REGIONAL SUSTAINABILITY TOMORROW SUITE

Unique integrated modeling suite connecting economic, land use, and transportation drivers to environmental and equity incomes.

SCHOOL BUS ROUTING OPTIMIZATION MODEL

Pioneering tool that pinpoints the smallest bus fleet needed to serve a school district under any start and dismissal schedule, saving districts more than 10 percent in annual transportation costs.

MULTIMODAL TRAVEL DEMAND METHOD

Novel method grounded in emerging data sources that produces monthly travel trends across all modes for any metropolitan area.

MTI tools and solutions provide more than $1 billion total economic benefit to the state of Maryland.

MTI AFFILIATED CENTERS AND LABS

- Bridge Engineering Software and Technology Center
- Center for Advanced Life Cycle Engineering
- Center for Advanced Study of Communities and Information
- Center for Advanced Transportation Technology
- Center for Advanced Transportation Technology Laboratory
- Center for Geospatial Information Science
- Center for Global Sustainability
- Center for Health and Risk Communication
- Experimental Economics Laboratory
- FAA Consortium in Aviation Operations Research
- Human Computer Interaction Laboratory
- I-95 Corridor Coalition
- Interindustry Forecasting Project
- Maryland Transportation Technology Transfer Center
- National Center for Smart Growth Research and Education
- National Transportation Center
- Supply Chain Management Center
- Traffic Safety and Operations Laboratory
- Unmanned Aircraft Systems Test Site
- Urban Computing Laboratory

MTI UNIVERSITY PARTNERS

UNIVERSITY OF MARYLAND · MORGAN STATE UNIVERSITY · UNIVERSITY of MARYLAND BALTIMORE · UNIVERSITY of MARYLAND EASTERN SHORE · FROSTBURG STATE UNIVERSITY

CENTER FOR ADVANCED TRANSPORTATION TECHNOLOGY LAB

Every day at the University of Maryland's Center for Advanced Transportation Technology (CATT) Lab, a team of 100 engineers, software developers, researchers, and other specialists make sense of the intricate transportation systems covering the United States, collecting, fusing, and analyzing more than eight billion transportation-related measurements from sources ranging from roadside sensors to GPS-enabled devices. The largest big data transportation archive in the world, the CATT Lab interprets data using RITIS—Regional Integrated Transportation Information System—a platform of over 40 analysis and visualization tools that help over 8,000 transportation professionals and researchers around the country tackle pressing transportation safety and mobility issues, such as plan for snow storms, monitor the impacts of incident response efforts on congestion, and meet federal reporting requirements.

Thanks to the Lab's Work Zone Performance Monitoring Application, for example, work zone managers can determine in real time if work needs to be put on hold or a lane needs to be reopened to keep traffic moving steadily.

Once the work is complete, officials can conduct a before-and-after study with RITIS tools that quickly measure and visualize the reduction in congestion, improved safety, and economic benefits to travelers and commercial vehicles from construction projects.

Some RITIS datasets go back as far as 25 years. The archive also includes continuous traffic speeds and travel time data for over one million miles of roadway beginning in 2010. For 30 states and counting, this archive means access to higher-quality data faster and at significantly lower costs, with some states seeing annual savings in the millions.

The federal government's Moving Ahead for Progress in the 21st Century Act (MAP-21) requires state and regional agencies to report travel times, reliability, delays, and other transportation performance measures. For most states and Metropolitan Planning Organizations (MPO), meeting these new requirements would have required hiring outside consultants or additional staff, adding potentially millions of dollars to their management costs over the coming years. MAP-21 Analytics Tools make it easy to compute, visualize, and download all required metrics at a fraction of the cost and in less than five minutes. Users can also output performance measures as charts, maps, and data files ready for reporting.

CATT Lab also oversees the federal National Performance Management Research Data Set, which is used by every state and MPO in the country to identify high congestion areas and times.

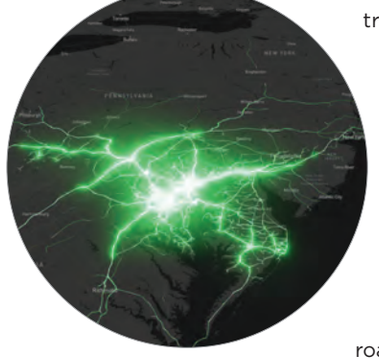
"Regardless of your technical background, our tools make it easy to answer complex questions quickly and effectively," says Michael Pack, who has led CATT Lab since it opened in 2002.

CENTER FOR GEOSPATIAL INFORMATION SCIENCE

Managing urban dynamics and transportation management often depend on an accurate understanding of physical environments and their relationship to human activity. With the help of advanced technologies—including computer models based on real-time data from multiple sources—researchers at UMD's Center for Geospatial Information Science (CGIS) are obtaining new insights about a wide range of location-based phenomena including cell phones, GPS sensors, or location-based apps.

The knowledge gained can assist lawmakers and policy specialists as they address a wide range of issues—everything from school district planning to determining the route of a new roadway.

"We're interested in the latest geospatial technologies and in data-driven approaches to understanding location-based phenomena," explains CGIS director Kathleen Stewart. Examples are many. In one project, CGIS researchers have been able to develop more accurate methods for obtaining vehicle mile travel estimates on local roads in Maryland, far surpassing the reliability of traditional procedures.



Stewart and her colleagues have also used data analytics to track travel patterns across the notoriously crowded Bay Bridge, calculate parking patterns at truck stops, and examine how social media platforms register the travel behavior of those who use them.

While these are complex endeavors, part of the center's mission is to present the information in ways that allow analysts to make sense of the data and identify key trends. "We create dynamic visualizations of vehicles on Maryland's roads," Stewart says. "We can show how, during the course of the day, these roads become busier, how the volume of traffic changes. With the Bay Bridge, we can show clearly how the activity accumulates—where the travelers are coming from, and where they are going. All these representations are produced using a computing framework."

Uniting many CGIS projects is the need for a more precise understanding of how individual choices—made by multitudes of travelers over the course of the day—combine to create larger phenomena. And while the research is interesting for its own sake, it's being conducted with the aim of addressing real-world problems, such as safety and congestion.

"Why do we do this? Because it can lead to much improved traffic and travel location management," Stewart says. "It provides decision support for lawmakers, policymakers, and state agencies."

"We can show what we've found and it can be taken into account along with other factors that an agency or organization might be aware of" she says. "Those responsible for making decisions about transportation or urban planning can take on board to adopt the contribution from our work."

JOHN S. BARAS
LOCKHEED MARTIN CHAIR IN SYSTEMS ENGINEERING
FOUNDING DIRECTOR, INSTITUTE FOR SYSTEMS RESEARCH

DATA-DRIVEN RESEARCH HELPS REVOLUTIONIZE THE WAY WE GET AROUND

An internationally-renowned thought leader whose work has helped transform fields ranging from automation to wireless communications, Dr. John Baras has long been involved in developing new approaches to transportation, mobility, and urban traffic management.

When Baras began his research career, bold thinking about transportation often ran into technological constraints. Today, many of those constraints are being overcome, thanks to dramatic increases in computing power combined with access to high-velocity, high-volume, real-time data. As a result, Baras says, "we're able to do things now that weren't possible thirty years ago."

A Maryland Transportation Institute (MTI) Affiliate, Baras is harnessing data-driven research to realize some of these possibilities. One such project would communicate traffic flow information between smart lights and cars as a way to reduce congestion. "The goal is to coordinate the lights with real-time data more closely than has been possible before," he explains. "In this way, we can do a better job of creating 'green waves'—that is, stretches where you won't encounter a red light if you're driving at normal speeds. And ultimately, we may be able to make serious progress in reducing congestion."

Real-time data already has helped drivers navigate their commutes more quickly and efficiently—just ask anyone who makes use of travel apps like Waze or MTI's newly-developed incenTrip. Baras is thinking beyond current uses, however; he believes that smart transportation systems will someday be able to actively manage traffic flows, guiding drivers along less-congested routes and steering them away from bottlenecks. In the future, he says, more of us will be riding in autonomous vehicles, which will pull data and choose routes based on that information. Cities and towns may employ the equivalent of an air traffic control tower, with sophisticated, computer-based systems controlling the movements of what—by that time—will mostly be autonomous vehicles.

Big thinking like this has helped cement Baras's reputation, but he is also attentive to smaller-scale problems—some of which, he notes, present the most formidable difficulties. Ensuring safe lane-changing, as well as safe passing on two lane roads, is of particular interest. It's a critical need for companies that are developing self-driving cars—and the problem, Baras says, arises from the unpredictability of the human drivers that are sharing the same road. "There are many kinds of drivers, many degrees of aggression, plus other factors that may influence a driver's behavior on a given day," he notes. "If all the cars on the road are autonomous, safety is less of an issue. It's the mixture that makes things difficult."

MTI's cutting-edge capabilities in gathering, aggregating, and representing traffic data provides essential support for Baras's research. "Especially with lives at stake, we must make sure that the models and simulations we develop are as accurate as possible. We are able to do this by matching them against the data gathered by MTI," he says.

"That way, when the results are applied in the real world, we don't get surprises."

It's a situation nearly every driver knows, and dreads.

The signal at an intersection changes to yellow, but you can neither stop comfortably nor beat the red light. Slam on the brakes, and you might get rear-ended. Continue on, and you might get caught by the red-light cameras—or, far worse, collide with cross-street traffic.

Traffic management experts call it "the dilemma zone," and it's responsible for many intersection accidents, says Civil and Environmental Engineering Professor Gang-Len Chang, who heads the Traffic Operations and Safety Lab at the University of Maryland's A. James Clark School of Engineering.

For more than ten years, Chang and his team have been devising smart control systems to reduce accident risks related to the dilemma zone—specifically, by configuring signals to respond dynamically to traffic with minimal hardware investment.

Chang found a novel way to lower the risk of angled crashes caused by failure to stop for a red light with a dynamic extension of the intersection's all-red phase, which leverages data collected through sensors found on all modern-day systems, including vehicle speed within the sensor's detection zone and distance to the intersection stop line.

"If we detect that the car is traveling at a certain speed when the light turns yellow, then we know whether that driver will be able to stop," Chang explains. "We can configure the signal to automatically delay the green light on the side street, so that cars and pedestrians don't enter the intersection before it is safe. And we can do this dynamically, in response to the specific conditions—if there's no speeding car, then there's no delay in the green."

Chang developed the system at the request of state highway authorities, following public outcry over a spate of accidents. Implementation has been a success and the angled-crash prevention system has formally been deployed at three intersections. Chang's latest research aims to extend the concept of dynamic signal

GANG-LEN CHANG
PROFESSOR, CIVIL AND ENVIRONMENTAL ENGINEERING
DIRECTOR, TRAFFIC SAFETY AND OPERATIONS LAB

IMPROVING INTERSECTION SAFETY THROUGH INTELLIGENT CONTROL TECHNOLOGIES

design to address the other kind of "dilemma zone" hazard: sudden stops at a yellow light that result in rear-end collisions.

In this case, smart signals can either intelligently terminate the green phase at the safest time point or dynamically delay turning yellow when they detect that a car or a platoon of vehicles is approaching too quickly. His team has already tested the concept and is planning a demonstration for June 2019; if successful, it will rank among traffic management "firsts" achieved in the state of Maryland. "It represents the first intelligent signal design in the traffic control field that can concurrently protect drivers from both rear-end collision and an angled crash at high-speed intersections," he notes.

Configuring signal design to promote traffic safety is something of a paradigm shift; historically, Chang says, signal design has been geared towards minimizing delays and congestion. "Tackling congestion remains a priority. But we're seeing more interest in the use of advanced technologies to keep people safe on the roads."

MING C. LIN
ELIZABETH STEVINSON IRIBE CHAIR OF COMPUTER SCIENCE
CHAIR, DEPARTMENT OF COMPUTER SCIENCE

DEVELOPING IMPROVED TRAINING FOR SELF-DRIVING CARS

Just like a human driver, a self-driving car has to learn all the maneuvers needed to navigate the roads, from making turns to passing other vehicles safely. It must also be taught how to respond to anomalies—a deer crossing the road, a patch of black ice, or a careless driver lurching into the wrong lane—that can cause accidents. And that's where the difficulty lies, says UMD Professor Ming Lin, an internationally recognized expert on virtual reality (VR) and robotics/AI.

Lin, who chairs UMD's computer science department, has been researching transportation and traffic management issues for years, using algorithms to calculate car trajectories and generate precise simulations of urban traffic flow. She and her team have also leveraged new technologies, such as VR, to experience and evaluate possible scenarios through "alternative realities." More recently, her perspective as a computer scientist and her extensive work in VR is helping to tackle a thorny problem affecting the training of autonomous vehicles: how do you provide them with the data they need to handle risky driving situations?

Here's the dilemma: self-driving cars are primarily taught by human drivers. But few human drivers will put themselves willingly in harm's way in order to generate the data needed to teach an automated vehicle what to do. "Nobody wants to be injured or killed in order to obtain that data," Lin notes.

Highly realistic simulations can help, Lin believes. With her team of graduate student researchers, she creates virtual worlds in which drivers encounter all types of the obstacles and hazards that characterize realistic driving environments—including anomalies and surprises.

"Essentially, we're trying to simulate vehicle accidents and then train autonomous cars by using these simulated accidents," she explains. "We vary the parameters systematically across the spectrum, creating simulated data that capture accidental scenarios."

"In some ways, training a self-driving car is like training human children," Lin says, "It's not enough just to teach them good behavior; they also need to learn the consequences of dealing with the catastrophic scenarios. With autonomous cars, we need to be able to see how the car is going to react to these unexpected events. How will it know what to do if there's no data with which to train it? The only way to train the car, with regard to these challenging situations that cause accidents, is by simulating them."

And understanding such situations, as rare as they may be, is crucial to safety. "As in many other areas of life, what you don't know can harm or even kill you—but finding out through actual, real-life testing is difficult and possibly unethical. Simulations and virtual environment offer a possible solution and an excellent alternative to this challenge," Lin says.

JENNIFER D. ROBERTS
ASSISTANT PROFESSOR, KINESIOLOGY
SCHOOL OF PUBLIC HEALTH

EXPLORING THE HEALTH IMPACT OF TRANSPORTATION BEHAVIOR

Public health is not an isolated issue. Many factors—including human behavior, transportation infrastructure, and the way we design our communities—can affect outcomes, making cross-disciplinary research essential. Through her pioneering research, University of Maryland Kinesiology Professor and MTI Affiliate Jennifer D. Roberts has been connecting the dots.

As director of the Public Health Outcomes and Effects of the Built Environment (PHOEBE) Laboratory, Roberts investigates the ways our human-constructed environments can impact health and well-being. Parks, libraries, residential and commercial spaces, transportation systems, and the layout of roads and sidewalks all play a role in influencing our day-to-day behavior and level of physical activity.

Roberts is spearheading a major multi-year study that will track the public health impacts of the Maryland Transit Administration's new Purple Line. This study, titled PLIGHT (Purple Line Impacts on Neighborhood, Health, and Transit), will pay particular attention to communities of color that live along the new light rail route in Prince George's County.

Roberts is also collaborating with Civil Engineering Professor Chenfeng Xiong on a new project that will add a health component to a travel app developed by MTI and the Center for Advanced Transportation Technology (CATT). The app, incenTrip, rewards users with points redeemable for Amazon or iTunes gift cards. Choices that result in less congestion—such as taking the Metro instead of driving in rush hour traffic—rack up a greater number of points.

With funding from an MTI Seed Grant, Xiong and Roberts will be developing additional, health-related capabilities for incenTrip, enabling users to see their activity duration, calories burned, and steps walked by engaging in active or human-powered transportation.

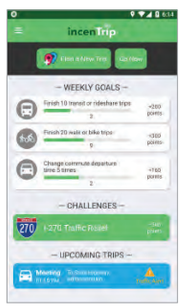
The project "brings together Xiong's expertise in travel behavior and my public health expertise," Roberts explains. "We'll be adding a new component that enables people to use the app not only to travel more efficiently but in a way that is more healthful, both as individuals and for the community as a whole."

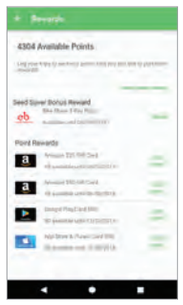
Influencing travel behavior isn't only a matter of raising awareness but encouraging people to change deep-seated habits of passive transportation, she says. Even in conditions that are optimal for walking or biking, we often hop in the car for a short ride to the store, simply because it's what we usually do. "We're so accustomed to driving that even though we might see that walking would be a desirable alternative, we don't necessarily follow through with that alternative decision," Roberts notes.

"Incentivizing health-promoting behavior, as we're seeking to do with incenTrip, can play an important role," she says. "Our goal is to help spur people to make decisions that will bring them the benefits of physical activity."

"Active transportation is not only important for public health, but for the environment—it means reduced tailpipe emissions and fewer cars on the road. The benefits are across the board, but it's not enough just to be conscious of them. It's also important to take action, through the travel decisions we make every day."

"INCENTRIP" SMARTPHONE APP USES PERSONALIZED INCENTIVES TO REDUCE CONGESTION, ENERGY USE, AND EMISSIONS





The National Transportation Center at the University of Maryland has developed a smartphone app that uses personalized, real-time multimodal traveler information to influence daily commutes and reduce congestion in Washington, D.C. and Baltimore. Called "incenTrip," the app leverages the latest big data, machine learning, and computing technologies to optimize traveler behavior for reduced congestion, energy use and emissions in a cost-effective way.

incenTrip has received funding from the University Transportation Centers program, the Federal Highway Administration's Exploratory Advanced Research program, the USDOE's Advanced Research Project Agency-Energy (ARPE-E), and more than a dozen state and local partners. The app is also backed by the Commuter Connections program at the Metropolitan Washington Council of Governments and Maryland Department of Transportation.

TECHNOLOGY INNOVATION

incenTrip employs a front-end smartphone app interface to deliver real-time traveler information and incentives that promote multimodal and shared mobility, off-peak travel, and smart routing/driving. When selecting a route, individuals are offered specific travel mode, departure time, and route options, with each scenario valued at a specific point level. For example, delaying a trip 30 minutes or using Metrorail might earn a user twice as many points than traveling during peak times or driving. Accrued reward points can be redeemed for gift cards, or for credits for transit or rideshare trips. While suggested routes and modes are designed to save commuters time and money, they also provide an overall system benefit by reducing congestion and overall travel time, energy use, and emissions.

The back-end technology for incenTrip includes: (1) a transportation behavior and dynamic traffic simulation model system for the entire Washington, D.C. and Baltimore region; (2) a unique machine-learning and rule-based travel behavior model for each incenTrip app user; and (3) an incentive optimizer that dynamically allocates incentive points to each individual user trip. For agency partners that provide incentive funding, incenTrip provides a customized performance dashboard with daily updates on program benefits in terms of congestion reduction, vehicle hours traveled, vehicle miles traveled, energy use, and emissions. It also offers more detailed statistics on user and user trip counts, actual travel behavior changes, incentive benefits by socio-demographical groups, and trip location.

TECHNOLOGY DEPLOYMENT AND COMMERCIALIZATION

With support from ARPA-E and other sponsors, the research team has established a startup company, Future Mobility Labs, to commercialize the incenTrip technology. The app, which is currently being piloted with users throughout the Baltimore-Washington region, will go live in July. Through Future Mobility Labs, researchers hope to pursue deployment in more regions across the nation.

INCENTRIP JOURNEY

NOV 2015

Project receives funding from the Federal Highway Administration's Exploratory Advanced Research (EAR) Program and the USDOE's Advanced Research Project Agency-Energy (ARPE-E).

MAR 2018

incenTrip Android app released for the Washington, D.C.-Baltimore region. incenTrip is one of six technologies selected by ARPA-E to be featured at the 2018 Energy Innovation Summit.

APR 2018

incenTrip iOS app released for the Washington, D.C.-Baltimore region

MAY 2018

University of Maryland and the Commuter Connection Program of the Metropolitan Washington Council of Governments (MWCOG) co-host an open house event showcasing incenTrip applications in travel demand management, integrated corridor management, congestion mitigation, and emissions reduction.

JUN 2018

incenTrip app wins DFHV Transportation Challenge Award for providing personalized and dynamic incentives that encourage ride hailing and for-hire trips that also reduce congestion and energy use.

AUG 2018

incenTrip featured in *The Washington Post*

SEPT 2018

incenTrip featured in *CityLab*

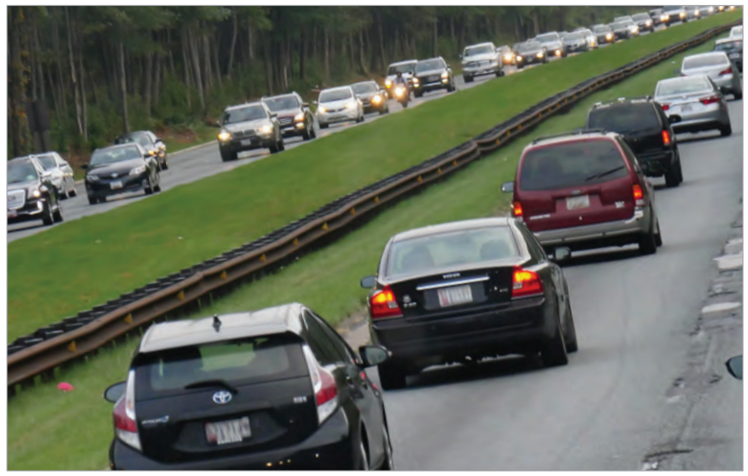
DEC 2018

MWCOG Commuter Connections Program announces incenTrip to more than 30,000 commuter account holders in its existing travel demand management program and adds incenTrip program funding to its annual fiscal budget.

FEB 2019

The Maryland Department of Transportation funds the expansion of the incenTrip app service area to the entire commute shed for all travelers who commute to the state of Maryland for work as part of the Commuter Choice Maryland Program.

IT'S NOT (JUST) ABOUT THE DESTINATION



Experts at the Maryland Transportation Institute (MTI) received $1.5 million from the Federal Highway Administration (FHWA) to chart the nation's travel demand and develop products for predicting future changes. Funded through FHWA's Exploratory Advanced Research Program, the three-year project will culminate in public domain origin-destination tables that shine a light on how travelers move between and within metropolitan areas.

As the name suggests, origin-destination tables—better known as OD tables—reveal how many trips travelers take between any origin and destination pair.

Transportation planners have long used these to understand travel demand. But MTI experts will propel the method to new heights by creating OD tables for trips between and within the nation's more than 300 metropolitan statistical areas using comprehensive location data from mobile devices.

"This project will revolutionize the way we collect, analyze, and predict travel behavior and demand," MTI Director and Herbert Rabin Distinguished Professor Lei Zhang said.

Zhang, along with Ph.D. student Sepehr Ghader and others, will tap into 2017 location data provided by companies like AirSage, INRIX and StreetLight Data to develop innovative methods that fill information gaps in traveler demographics, travel modes, trip purposes, and more.

The OD tables will serve as the foundation for a microsimulation model that officials could use to predict future national travel demand and determine how well a proposed project will meet that demand before investing in it.

Throughout the project, the MTI team will work closely with partners at the University of Maryland Center for Geospatial Information Science, the Maryland State Highway Administration, the Baltimore Metropolitan Council, and a number of data providers.

TAPPING INTO THE LARGEST TRANSPORTATION BIG DATA ARCHIVE IS EASIER THAN EVER

Members of the American Association of State Highway and Transportation Officials (AASHTO) now have direct access to a suite of web-based tools that make it easy to set targets and submit data under the federal legislation known as MAP-21. UMD Center for Advanced Transportation Technology Laboratory (CATT Lab), the MAP-21 Analytics Tools have been adopted by 30 states to improve system performance and combat freight congestion.

The tools are available through AASHTO's Transportation Performance Management pooled fund.

"We are proud to be able to bring our expertise to bear to equip states and regions with these cutting-edge tools that improve users' access to critical data and reduce the time and money needed to meet federal reporting requirements," said Michael Pack, director of CATT Lab.

The Moving Ahead for Progress in the 21st Century Act requires state and regional agencies to report on travel times, reliability, delays, and other transportation performance measures. The information and data generated is expected to inform local transportation planning and decision making while also allowing the Federal Highway Administration (FWHA) to better assess the impacts of federal funding investments.

CATT Lab's MAP-21 Analytics Tools make it easy to compute, visualize, and download all required metrics. Users can also output performance measures as charts, maps, and data files ready for reporting up to FHWA.

CATT Lab, part of UMD's Department of Civil and Environmental Engineering, houses the largest transportation big data archive in the world and focuses on solutions for operations and planning. With a team of more than 100 engineers, software developers, and researchers, the lab develops analysis, visualization, training, and educational tools that transform transportation planning, resource use, coordination, and real-time operations by local, state, and federal agencies, as well as private companies.

UMD, along with partners INRIX and the Texas A&M Transportation Institute, was selected by AASHTO to be their sole provider of highway performance analytics in 2018.

MARYLAND TRANSPORTATION INSTITUTE ANNOUNCES SEED GRANT WINNERS

Six research proposals have been selected to receive grants of up to $50,000 as part of a newly established Seed Grant program at the UMD Maryland Transportation Institute (MTI). Through the seed grants, MTI aims to spur collaborative projects that bring together transportation researchers across multiple colleges at UMD to conduct innovative research with broad societal and economic impact. In addition, the grant program is intended to yield at least one major external funding proposal.

Researchers selected for grants this year will be investigating a wide range of interdisciplinary topics. In one project, John Dickerson and co-PIs Ilya Ryzhov and Aravind Srinivasan will be studying the application of deep reinforcement learning—a type of machine learning—to rideshare dispatch.

In their project, Cinzia Cirillo and Partha Lahiri will investigate the use of Bayesian data science methodology in analyzing travel statistics. Sevgi Erdogan, together with Cirillo and Vanessa Frias-Martinez, will be developing a novel land use and transportation model for the Baltimore-Washington region.

A proposal by Chenfeng Xiong and Jennifer Roberts, meanwhile, focuses on the nexus of transportation and health by influencing travel behavior through use of integrated health measures and incentives technology, while Thomas Jacobs and Gerrit Knaap will assess the feasibility of object detection and communication systems for connected vehicles in smart cities.

Finally, Kathleen Stewart will collaborate with Xiong in developing a new foundation for travel behavior analysis, based on the fusion of social media data and big mobile device data.

Following a Request for Proposals announced earlier this year, the six projects were selected from among submissions that involved UMD researchers from nine different colleges. Future MTI seed grant funding opportunities are expected to be announced in the fall semester annually, starting in the fall of 2019.

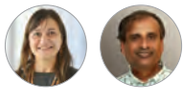
“We congratulate the winners and encourage those that were not chosen to try again next year,” said MTI’s director, A. James Clark School of Engineering’s Herbert Rabin Distinguished Professor Lei Zhang. “The submitted proposals were of very high quality and making a selection of only six presented a challenge.”

“The MTI’s Seed Grant program is designed to make a major contribution to transportation research by fostering new, multidisciplinary collaboration,” Zhang said. “New technologies and approaches, including machine learning, data science, and automation, are opening up exciting new avenues for transportation research. We’re confident that the selected proposals will advance the field, attract major external funding to UMD, and help address real-life transportation issues that people encounter every day, particularly in the highly congested D.C.-Baltimore region.”

Established in April 2018 through the FY2018 Provost’s Initiative, MTI is a research, workforce development, and technology transfer hub with a mission of advancing innovation in the transportation sector and related fields. It leverages the largest transportation data and data analytics center in the nation and a U.S. Department of Transportation-designated National University Transportation Center. MTI also has affiliated centers in smart growth, GIS, logistics, sustainability, computer sciences, behavioral sciences, and public health, and more than 100 affiliated faculty members at UMD in all twelve colleges.

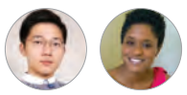
FY 2018-19 MTI SEED GRANT AWARDEES

John Dickerson, Ilya Ryzhov, and Aravind Srinivasan
Deep Reinforcement Learning for Rideshare Dispatch
College of Computer, Mathematical, and Natural Sciences; Robert H. Smith School of Business



Cinzia Cirillo, Partha Lahiri
Bayesian Data Science Methodology for Transportation Statistics at Granular Levels
A. James Clark School of Engineering; College of Computer, Mathematical, and Natural Sciences

Sevgi Erdogan, Cinzia Cirillo, and Vanessa Frias-Martinez
A Multi-Agent Land-Use and Transportation Model Suite for Baltimore-Washington Region
School of Architecture, Planning & Preservation, A. James Clark School of Engineering; and College of Information Studies



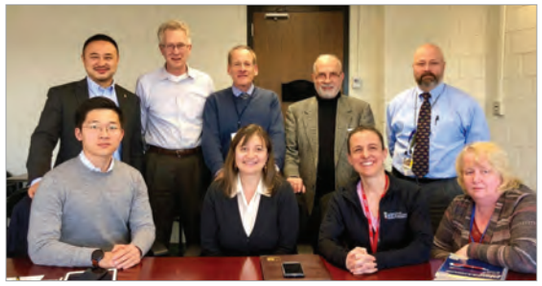
Chenfeng Xiong, Jennifer D. Roberts
Using Integrated Health Measures and Incentives Technology to Improve Transportation and Advance Public Health by Influencing Travel Behavior
A. James Clark School of Engineering; School of Public Health

Thomas Jacobs, Gerrit Knaap
Feasibility Assessment of Object Detection and Communication Systems for Connected Vehicle Applications
A. James Clark School of Engineering; School of Architecture, Planning & Preservation

Kathleen Stewart, Chenfeng Xiong
Fusing Social Media Data with Big Mobile Device Data as a New Foundation for Travel Behavior Analysis
College of Behavioral and Social Sciences; A. James Clark School of Engineering

TRANSPORTATION AND HEALTH INITIATIVE

The University of Maryland, College Park (UMD-CP) and University of Maryland, Baltimore (UMB) have partnered to create a bi-campus program in transportation health. This interdisciplinary initiative serves to integrate transportation-related big data health care management and analytics to reduce traffic crash and pedestrian trauma-related deaths and morbidity, and to create new technology and jobs in health care data analytics and "smart health."



UMD-CP team members include the Maryland Transportation Institute (MTI), the A. James Clark School of Engineering, and the School of Public Health. UMB members include the Center for Shock, Trauma and Anesthesiology Research, the National Study Center for Trauma and Emergency Medical Systems, the R. Adams Cowley Shock Trauma Center, and the University of Maryland Medical Center.

The initiative focuses on three broad research areas in transportation health. First, it looks to enhance analytic and predictive capabilities for data linkage procedures that allow the integration of EMS, law enforcement, and medical systems after motor vehicle accidents to improve transport efficiency of injured persons and pre-hospital care. Second, the initiative will combine the crash investigation experience and data linkage capabilities of the NSC with the engineering expertise of MTI to improve causation analysis on reconstructed cases for pedestrian injuries, permitting the assessment of potential mitigation strategies such as redesigned cross walks, revised traffic flow, or other infrastructure revisions. Third, by utilizing the analytical and computational expertise of MTI, the initiative will realign transport and pre-hospital data and data from the evolving UMMC trauma registry to ensure they are more accessible to clinical research.

This institutional partnership poises the University of Maryland as an international leader at the nexus of interdisciplinary transportation and health research. The initiative currently has $150,000 in funding and ultimately hopes to receive external funding from the National Institute of Heath, National Science Foundation, the U.S. Department of Transportation, and National Highway Traffic Safety Administration.

HOGAN ADMINISTRATION LAUNCHES WESTERN MARYLAND WORK GROUP FOR AUTONOMOUS TECHNOLOGY CENTER BASED ON MTI RESEARCH

In September 2018, Gov. Larry Hogan's administration announced an eight-person work group to pursue recommendations from a Maryland Transportation Institute study regarding the development of a potential Autonomous Technology Center (ATC). Funded in part by the Appalachian Regional Commission, the study examined the technical, economic, and regulatory feasibility of establishing a center in western Maryland.

Autonomous technologies cover a wide spectrum, from unmanned aerial systems and connected autonomous vehicles to industrial robotics, cybersecurity, and data analysis on autonomous systems.

"Along with existing autonomous technology centers in Aberdeen and southern Maryland, this western Maryland ATC would make the state of Maryland an autonomous technology delta and promote the state as a leading national hub in autonomous technology innovation," said MTI Affiliate and Department of Civil and Environmental Engineering Associate Professor Qingbin Cui.

For the study, Cui and Lei Zhang, director of MTI and Herbert Rabin Distinguished Professor, identified industry interest, analyzed market potential, selected technology areas, and determined facility needs.

"This feasibility study is a perfect example of how MTI can bring to bear our interdisciplinary expertise from colleges across the University of Maryland to improve quality of life and economic development in Maryland," said Zhang.

The work group is charged with making recommendations on a site location and funding sources. They will also refine design and cost estimates for construction, identify partnership opportunities, and establish the needs of stakeholders that would use the facility.

NEW MOBILITY DRIVING ECONOMIC DEVELOPMENT INITIATIVE

Emerging mobility technologies characterized by sharing, connectedness, automation, and electrification will not only change the way we move and how our goods move, but also fundamentally change key components and processes of our economic system. How can Maryland and the rest of the world maximize the economic benefits and job creation effects of new mobility systems? MTI has launched a new initiative to study the mechanism through which future mobility technologies affect the labor markets, supply chain, emerging industry sectors, and gross regional products. The goal is to provide policy recommendations that can help government agencies and the private sector maximize the economic benefits of new mobility.

BIG DATA FOR SAFETY INITIATIVE

In 2017, 37,133 people in the United States were killed in motor vehicle crashes. In Maryland alone, there were 557 traffic-related deaths. Vulnerable population groups such as seniors, pedestrians, and bicyclists are disproportionally affected by traffic accidents. Big data analytics provide new ways of assessing traffic safety, exposure, risks, and countermeasures. MTI researchers are using new data sources to map conflicts between pedestrian/bicyclists and motor vehicles at the roadway and intersection level, which helps decision makers better understand the true causes of each traffic accident and more effectively identify solutions.

EDUCATION AND WORKFORCE DEVELOPMENT PROGRAMS

The University of Maryland offers a wide range of transportation education and workforce development programs, including degree programs, a joint internship program, certification programs, professional training courses and workshops, an annual MTI conference, and a webinar series.

EDUCATION PROGRAMS

- Ph.D. in Transportation Engineering, Urban Planning, and other transportation-related fields
- Master of Science in Engineering, Planning, Economics, Supply Chain Management, and other transportation related fields
- Master of Engineering
- Master of Public Policy
- Master of Professional Studies
- Bachelor's degree in Civil and Environmental Engineering with the option for a transportation and project management focus
- Certificate in Traffic Engineering Operations
- Consortium for Innovative Transportation Education (CITE) Certificates

CONSORTIUM FOR INNOVATIVE TRANSPORTATION EDUCATION

The Consortium for Innovative Transportation Education (CITE) is part of the Center for Advanced Transportation Technology and stands as a unique organization of university and industry.

CITE furthers the goals of safety and reliability in the transportation system through training and education with both academic and industry partners. CITE provides transportation engineering students and professionals with an integrated curriculum covering a wide range of topics related to Intelligent Transportation Systems (ITS)—from information technology to performance management.

CITE offers five certificate programs and more than 30 online courses to increase the number of transportation management and operations professionals. It also partners with the Institute of Transportation Engineers (ITE) to provide professional development opportunities.

PALS—PARTNERSHIP FOR ACTION LEARNING IN SUSTAINABILITY

Established in 2013, the University of Maryland Partnership for Action Learning in Sustainability (PALS) is a campus-wide initiative that pairs faculty expertise and student ingenuity to tackle a variety of sustainability-related issues facing Maryland communities, such as urban revitalization, storm water and solid waste management, public health, and economic development. To date, the program has engaged four counties, four of the state's largest cities, and several community associations, providing over four million dollars in project value.

PALS has partnerships with 11 colleges and schools and has sponsored over 125 projects statewide.

STUDENT AND ALUMNI STORIES

DAVID DONALDSON

David Donaldson is a Clark Doctorate Fellow finishing his Master's in Transportation Engineering at the University of Maryland. He completed his Bachelor of Science in Civil Engineering at West Virginia University. He conducts research in evolving transportation areas such as big data analytics, traffic simulation, travel behavior analysis, and connected and automated transportation. His work in automated transportation contributed to the establishment of the Western Maryland Autonomous Technology Commission, whose job it is to review and refine MTI's recommendations for a new autonomous technology center in western Maryland.

Donaldson is currently utilizing vehicle probe data analytics and mesoscopic simulation tools to analyze the traffic impact and trip generation for the three largest casinos in Maryland. He is also supporting MTI's efforts to engineer a comprehensive major transportation project database for the Federal Highway Administration (FHWA). Upon graduation, David intends to utilize his knowledge and expertise to jump-start his career as a traffic engineer/planner.

MINHA LEE

Minha Lee is a fifth-year Ph.D. student in the Department of Civil and Environmental Engineering. She was awarded the 2018 Women's Transportation Seminar D.C. (WTS-DC) Chapter Doctoral Scholarship.

Fascinated by the similarities between blood veins and road networks, Lee's interest in transportation engineering began at an early age. Her research, conducted as part of the Maryland Transportation Institute, focuses on developing an online decision support system that includes integrating simulation-based traffic models with active traffic management strategies.

"It is my belief that transportation engineers should assume a degree of responsibility by designing movements that seamlessly connect all individuals living in the global community," she explains.

MICHAEL MANESS

Dr. Michael Maness earned his Ph.D. degree from the Department of Civil and Environmental Engineering. At UMD, he conducted research into the methodology and application of behavioral modeling in urban and regional systems, travel behavior, emerging technologies, modeling social interactions, sustainable transportation, choice modeling, and travel survey methods. Dr. Maness's Ph.D. dissertation won the Eric Pas Best Dissertation Prize from the International Association of Travel Behavior Research. He was also a recipient of the USDOT University Transportation Centers Program Outstanding Student of the Year, a two-time Eisenhower Transportation Fellow, and a former Bridge to the Doctorate Fellow.

Following his postdoctoral work at the Oak Ridge National Laboratory, Dr. Maness was recently appointed as a tenure-track assistant professor in the Department of Civil Engineering at the University of South Florida.

MARYLAND TRANSPORTATION INSTITUTE SEMINARS

SMITH CONSIDERS POLICY CHALLENGES ARISING FROM INNOVATION

From artificial intelligence to unmanned and autonomous systems (UAS), technology is reshaping transportation. In a seminar presented by MTI in September 2018, Loren Smith from the U.S. Department of Transportation (DOT) surveyed the ways in which policymakers and regulators are responding to these tectonic changes.

Smith, who is senior advisor in the Office of the Under Secretary for Policy at the DOT, laid out the three pillars that are guiding efforts to help the transportation system adapt: ensuring safety, rebuilding the nation's infrastructure, and preparing for the future.

In his presentation, Smith discussed major areas of focus at the DOT, including automated vehicles, unmanned aircraft systems, regulatory reform, commercial space, supersonic aviation, the President's infrastructure plan, and the Safety Data Initiative.

Smith's experience in the transportation field spans both the public and private sector, including seven years as an transportation policy analyst for Capital Alpha Partners, a research firm in Washington that studies public policy for investors. Smith also served on the President-elect's transition team as landing team leader for the Department of Labor and formerly worked under Secretary Elaine Chao.

NIEMEIER EXAMINES SOCIAL IMPACT OF DEGRADED INFRASTRUCTURE, CLIMATE CHANGE

Deb Niemeier, whose research on tailpipe emissions has helped shape California state policy, and whose current work explores the link between social justice and sustainability, delivered an MTI seminar on April 23 in conjunction with the Mpact Lecture Series.

Niemeier, a National Academy of Engineering (NAE) member and professor in both the Department of Civil and Environmental Engineering and the School of Education and Biological and Agricultural Engineering at the University of California at Davis, spoke on the topic of "Fire in Paradise: Aging Infrastructure, Climate Change, and Inequality."

Over a career spanning more than two decades, Niemeier has worked to develop highly accurate, accessible processes for emissions modeling and travel behavior models that can be used in the public sector, with particular attention to environmental health disparities and governance processes. She is a Fellow of the American Association for the Advancement of Sciences (AAAS) and was elected to the NAE in 2017. She has also served as editor-in-chief of Sustainable Cities and Society and Transportation Research, Part A, the leading international journal focused on transportation policy and practice.

MTI OUTREACH

MTI EXHIBIT AT THE TRANSPORTATION RESEARCH BOARD ANNUAL MEETING

The University of Maryland's Department of Civil and Environmental Engineering (CEE) had a strong showing at the 2018 Transportation Research Board (TRB) Annual Meeting. The Maryland Transportation Institute and the CATT Lab hosted an exhibit showcasing their latest research and project work. CEE faculty, staff, and students gave over 40 lectures, workshops, and poster presentations during the four-day event, and helped chair three sub-committees. Eleven papers were accepted by the TRB for publication or are under a second review.

MTI researchers and students hosted a booth and participated in a variety of committees and workshops.

6TH INTERNATIONAL TRANSPORTATION AND ECONOMIC DEVELOPMENT (I-TED) CONFERENCE

MTI was a co-organizer of the 6th International Transportation and Economic Development (I-TED) Conference last June on "Relationships between Multimodal Transportation & Economic Development: Policy, Infrastructure, & Technology." I-TED is a collaboration between the Transportation Research Board, Federal Highway Administration and the University of Maryland; it convenes every four years to discuss approaches and research to integrate mobility that enhances communities' ability to develop a sustainable economy.

MARYLAND DAY

The Maryland Transportation Institute presented its innovative incenTrip app at the Research in Your Life booth during the 21st Maryland Day in April. Maryland Day is one of the most popular annual events in the DMV area, with over 400 free, family-friendly events across campus.

MDQI

The Maryland Transportation Institute attended the 2019 Maryland Quality Initiative (MdQI) conference in January. MdQI is an effort by the Maryland transportation industry dedicated to improving planning, construction, and maintenance of the state-wide transportation system. MdQI has expanded to include nearly all modes of transportation, and federal and county agency partners.

Critical Maryland Transportation Challenges

MOST CONGESTED URBAN AREAS IN THE U.S.

#4

Washington, D.C. and its Maryland suburbs

#19

Baltimore

COST OF CONGESTION TO THE ECONOMY

$4.3 Billion

Annual cost of traffic delays endured by Marylanders.

+

$1.5 Billion

Additional congestion cost to the Maryland economy.

$1,251 Annual cost of delays **for each worker** in Maryland.

AGING INFRASTRUCTURE

Aging infrastructure costs more than

$2,200

per year, per MD driver in auto repair and gas. Maintenance needs are limiting Maryland's ability to strategically invest for economic and job growth.

333 of the 5,291 bridges

in Maryland are **structurally deficient.**

20% of the 4,596 major roads

in Maryland **are in poor condition** per USDOT report.

PUBLIC SAFETY

Injuries and fatalities from traffic accidents in 2017 in MD:

51,500 **Injuries**

557 **Fatalities**

Data-driven Solutions Offered by the Maryland Transportation Institute

ENHANCING SAFETY THROUGH TECHNOLOGY

Developing technologies for zero traffic fatalities through advanced research on:

- Safety countermeasures
- Accident response
- Connected and automated vehicles

REDUCING INFRASTRUCTURE COSTS

Innovative research on construction contracting, project financing, low cost and recycled materials, asset management, and bridge engineering **saves Maryland $260 million each year** on transportation infrastructure costs.

10% reduction in transportation infrastructure costs **saves each Maryland taxpayer $619** per year, and **saves an additional $220** per year for each Maryland driver in transportation costs.

Cutting-edge **visual analytics tools help prioritize billions of dollars** in transportation investment decisions and answer tough questions by measuring and communicating the economic and environmental impact of congestion, major construction projects, weather events, closures, and accidents.

CONGESTION MITIGATION

A systematic approach including:

- Integrated corridor management
- Active traffic management
- Advanced traveler information
- Freight routing decision support
- Travel demand management

DECREASING ENERGY USE AND EMISSIONS

Smartphone-based traveler guidance and incentive technology to **reduce 10% of transportation energy** use and GHG emissions in MD.

MODELING AND SIMULATION

UMD contributes to the modeling and simulation analysis of the planned **I-270 congestion mitigation** to attract hi-tech and other businesses to Maryland.

EMERGENCY RESPONSE TECHNOLOGY

New technology based on **smartphone apps, social networking, crowd sourced data, and big data analytics** helps optimize emergency response planning and operations, saving lives and reducing disaster costs.

DISASTER RESILIENCE AND GLOBAL CLIMATE CHANGE ADAPTATION RESEARCH

Prepares Maryland for malicious and natural disaster events, accounting for interdependencies between transportation, power, water, and societal systems.

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