Center for Advanced Infrastructure and Transportation
Newsletter Issue 18 • October 2017

RUTGERS

transportation today

>> Mobile bridge evaluation invention is "a hit"

A new tool that delivers fast, accurate bridge load-capacity estimates

inside

Timing couldn't be better for Rutgers CAIT to dispatch a new, innovative device that could change how 600,000-plus bridges in the United States are routinely assessed and rated. It starts by giving them a good hard whack.

According to the ASCE 2017 Infrastructure Report Card, the average age of U.S. bridges is 43 years, and more than 56,000 are rated structurally deficient. Aging is inevitable of course, but in addition, today's traffic volumes and loads on many older roads and bridges are far beyond what they were initially designed to carry.

Considering these realities of time and demand, the introduction and deployment of the Targeted Hits for Modal Parameter Estimation and Rating (THMPER™)—the first technology of its kind—is a timely leap forward.

THMPER was created by Drs. Franklin Moon, John DeVitis, David Masceri, and Emin Aktan. Moon and his coinventors started flushing out the idea in 2010 while he was teaching at Drexel University and simultaneously engaged with CAIT on the FHWA Long-Term Bridge Performance Program. Moon joined the Rutgers School of Engineering faculty in January 2016.

In addition to inspecting bridges every two years, owners also routinely estimate their safe load-carrying capacity. Erring on the side of caution, if owners believe a bridge might be compromised, they may choose to set a maximum weight for vehicles permitted on it. Some of these postings are necessary and appropriate,

>> p2

Time and tides

Only weeks before the five-year anniversary of Hurricane Sandy—the 2012 superstorm that devastated our region—its memory was eclipsed by two Category 4 storms that hit so close together that they virtually blurred into one: Harvey and Irma. This was the first time that two hurricanes of that magnitude made landfall in the United States within one year, never mind within less than two weeks.

Hurricane Harvey brought epic rains to southeast Texas. The catastrophic flooding throughout the region shut down oil refineries and the Houston shipping channel, causing gasoline prices to spike in much of the country.

Hurricane Irma hit the Florida Keys full force on September 10, then zigzagged up the length of the state, knocking out electricity for at least 6 million residents. Some reports say 80 percent to 90 percent of Florida's crops were destroyed. Severe flooding and high winds left a path of destruction, coastal flooding, and power outages from the Everglades to South Carolina.

Conservative estimates put Harvey's economic impact at around $130 billion; for Irma costs are approaching $100 billion. When you add in losses from hurricanes Sandy ($71.4 billion), Katrina ($160 billion in today's dollars), and Ike in 2008 ($29.5 billion), total costs approach half a trillion dollars for just those five storms.

These estimates don't take into account myriad cascading regional impacts: stalled businesses, layoffs and sparse employment opportunities, degraded environments, negative health effects, and ruined lives. The fact is, storm costs continue to rise for many months after insurance companies have tallied their numbers.

Scientists have long been sounding an alarm about the increasing frequency and intensity of severe weather. Since it is unclear when—or if—we will see an infrastructure plan or budget approved by Congress, we have to rely on the ingenuity of engineers, researchers, and other innovators for solutions to preserve and protect our networks.

For transportation infrastructure, the writing is on the wall. We know strong, well-maintained bridges, roads, energy networks, dams, levees, and stormwater systems stand up to the forces of nature—and the simple ravages of time—more readily than those that are near or past their designed service life. America can pay now to fortify our infrastructure and make it less vulnerable before disaster strikes, as well as more resilient once the storms have passed. Or, we can pay later to put them back together after extreme weather events. Remember, even without the threat of natural disasters, an alarming amount of our country's infrastructure is not just old, but operating over capacity, which is accelerating its decline.

CAIT and its UTC partners are developing and deploying more advanced technologies for evaluating and monitoring the health of our assets. We are collecting and analyzing data that is crucial for understanding everything from concrete deterioration to human safety factors. Researchers are developing models that can help agencies optimize performance, calculate risk, identify "chinks in the armor," proactively intervene, and prepare swift and adequate responses to emergencies. We are improving materials and engineering methods that extend the life of existing structures and make new construction stand stronger and last longer.

Academic research has provided insight and put multiple groundbreaking products and tools into the hands of transportation agencies and onto roads and bridges across the country. And we will continue to do so for the foreseeable future.

With the will to make the country's infrastructure more durable and resilient, and the resources and support to continue our work, we believe we can tackle any challenge Mother Nature or Father Time throw our way.

Ali Maher, Ph.D., Director ■

ON THE COVER: Faster, cheaper, and less disruptive than conventional methods, THMPER™ provides highly accurate refined load ratings. A drop weight delivers a forceful blow to the bridge and sensors record the structure's vibration response. Data is processed on the spot using custom software. *Photo: Andrew Katz/Intelligent Infrastructure Systems, a Pennoni Company.*

<< p1 Mobile bridge evaluation

but not in every case. It is not uncommon that a restricted bridge is actually able to safely carry more than the posted weight. That's because widely used, simplified approaches to determine load-carrying capacity don't always reflect a structure's true limit.

The downside of underestimating load-carrying capacity is largely socioeconomic, in the sense that it may unnecessarily exclude heavier emergency vehicles or lessen efficiencies in trucking, which negatively impacts commerce. Recognizing this, the *AASHTO Manual for Bridge Evaluation* does permit owners to employ more advanced approaches, but historically those have proven cost prohibitive for large-scale implementation.

THMPER uses the more refined approaches that are outlined in the AASHTO manual: modal impact testing, refined analysis, and calibration of finite element (FE) models. THMPER's rapid testing is groundbreaking because it uses *all three* of those methods, plus, it's portable and performs the whole operation on site, thanks to custom software and a mobile data processing lab. This means THMPER can determine bridge load ratings faster and more economically than conventional methods, thus removing the cost barriers that formerly kept owners with large inventories from implementing the more refined and accurate methods.

As its name implies, THMPER delivers a forceful impact with a drop weight, causing the bridge to vibrate. How the bridge responds reveals a lot about its load-carrying capacity.

Moon explains: "The impact from THMPER generates a free vibration response in the bridge.

How THMPER™ measures up against other load estimation methods

Technology	Method	Est. prep time	Est. test time	Est. report time	Access equip. needed?	Bridge closure
Quasi-static with displacement transducers	Ambient monitoring	5–10 days	2–5 days	3–5 days	Yes	Only underside
	Load testing	5–10 days	1 day	3–5 days	Yes	Partial, 2 hrs
Dynamic	Ambient vibration	5–7 days	2–5 days	5–7 days	Yes	Only underside
	MIMO impact	5–7 days	1 day	5–7 days	Yes	Partial, 2 hrs
	THMPER	**Under 1 day**	**30 min/span**	**1 day**	**No**	**Slowdowns only**

> **“The impact from THMPER™ generates a free vibration response in the bridge. ... How the bridge responds reveals a lot about its load-carrying capacity.”** — Franklin Moon

It’s somewhat analogous to plucking a guitar string and then recording its distinct vibration profile.

“We ‘thump’ the bridge at predetermined spots distributed across the deck and capture the frequency of the vibrations and the shapes the bridge assumes at which frequencies. These data give us important performance measures related to stiffness and mass, which in turn tells us how truck loads are distributed to key elements,” Moon says.

Sensors record the dynamic signature of the bridge and feed data in real time directly to technicians in the mobile lab. The data are processed and used to calibrate a refined FE model, which indicates how much load a bridge can safely carry.

“THMPER does a really good job at picking up a key aspect of the bridge response in the torsional and so-called butterfly mode, i.e., how the girders share the load transversely.

The *AASHTO Manual for Bridge Evaluation* references all the methods and practices we’re combining here,” says Moon. “We’re packaging it in a really efficient and cost-effective way, but fundamentally it’s not very different than the standards established and accepted by AASHTO.”

THMPER can test a 100-foot, three-lane bridge in about 45 minutes, and evaluate an estimated 300-plus bridges per year for about 25 percent the cost of current testing methods. It captures quantitative data quickly, minimizing lane closures that disrupt traffic, and provides accurate load-capacity results in about one day.

ASCE recognized the value and ingenuity of THMPER by awarding it the 2016 Charles Pankow Award for Innovation.

To date, THMPER has been used to assess more than 30 bridges in Delaware, Maryland, New Jersey, Pennsylvania, Oregon, and Washington under pilot programs with federal, state, and local transportation agencies. ■

Left: THMPER is considered groundbreaking because it uses three advanced load-capacity estimating methods: modal impact testing, refined analysis, *and* calibration of finite element models. Plus, it’s portable, self-contained, economical, and provides accurate results in just one day. *Photo: ©David Masceri/Rutgers CAIT.*

Putting Rutgers innovations up for adoption

CAIT was a major contributor at an event hosted by the Department of Civil and Environmental Engineering (CEE) to showcase important Rutgers-developed technologies and products.

The Emerging Technologies in Civil and Environmental Engineering Symposium held in May was a three-way dialogue—between agencies' top management, industry leaders, and the academic community—about the future of transportation, its current needs and challenges, and solutions Rutgers has innovated over the last few years.

Since transportation is the glue that holds our economy together, agencies' decisions have significant financial impacts. Their choices also directly affect public safety, the condition of roads and bridges, and even whether you get home for dinner on time. With responsibility for a vast, complicated, multimodal network, agencies are rightly hesitant to adopt new materials, methods, and tools.

This full-day symposium gave researchers the opportunity to present concrete evidence of the practical, applicable benefits of research and the products it bears. Dean Thomas Farris (School of Engineering), Dr. Nenad Gucunski (CEE chair and symposium host), and Malcolm McLaren (McLaren Engineering Group) welcomed attendees, panelists, and presenters and introduced the first group of presentations: "RU Innovating Infrastructure." CEE faculty shared recent trends and breakthroughs like robotic and mobile tools for bridge evaluation; new pavement technologies; analyzing risks for transporting hazmats by rail; big data analytics and modeling; and virtual reality applications in infrastructure engineering.

The next panel comprised several highly respected industry leaders: Anthony Bartolomeo (president and CEO, Pennoni), Michael Cobelli (president and CEO, Skanska USA Civil), Robert Fischer (chief engineer, New Jersey Turnpike Authority), David Lambert (assistant commissioner, NJDOT), Patrick Natale (VP, Mott MacDonald), Edward Schmeltz (senior VP, AECOM), James Starace (chief engineer, Port Authority of New York and New Jersey), and Gardner Tabor (chief safety officer, NJ Transit). This distinguished group talked about how engineering innovations are changing realities in their particular sectors.

Following the afternoon keynote address by Bob Prieto (chair and CEO, Strategic Program Management), it was time to show off innovations that have stemmed from CAIT research contracts: The BEAST™ accelerated bridge-testing lab; THMPER™ (see cover story); RABIT™ robotic bridge-deck inspection tool; and a relatively new lab led by Dr. Jie Gong, the Advanced Construction Technology (ACT) lab, which is using spatial sensing and large spatial data sets for mapping and virtual reality visualization in civil engineering.

The afternoon program continued with presentations on engineering innovations that effect positive change in communities while treading lightly on the environment. Rutgers CEE faculty members Nicole Fahrenfeld, Jie Gong, George Guo, Peter Jin, and Ali Maher presented.

Andy Ciancia (principal and COB, Langan) moderated a related panel discussion on the role of engineering in shaping communities and protecting the environment. Panelists were Anthony Bartolomeo (Pennoni), Stephen Dilts (HNTB New Jersey office), Scott Douglas (dredging program manager, NJDOT), Mitchell Erickson (science advisor, DHS), Daniel Kennedy (assistant commissioner, NJDEP), C. William Kingsland (assistant commissioner, NJDOT), and John Scheri (senior VP, Mott MacDonald).

The Emerging Technologies symposium galvanized both researchers and business to champion change in the transportation industry. The plan is to hold the event again in two years, but it opened pathways for immediate and ongoing discussion between thought leaders in all three realms—industry, agency, and academic. ■

Above: Unique projects and creations CAIT shared at the symposium (L to R): RABIT™ bridge deck assessment robot, the BEAST™ accelerated bridge testing lab, and a pneumatic tube mixing sediment stabilization demonstration project. *Photos: ©Drew Noel Photography/Rutgers CAIT.*

Mother Nature says, "You ain't seen nothin' yet."

Understanding storm recovery and community resilience

October 30, 2017, is the fifth anniversary of Superstorm Sandy. For those five years, it has held the record for the second-most deadly, destructive, and costly storm in U.S. history. At between 900 and 1,100 miles in diameter, it is still the largest Atlantic hurricane on record. But it doesn't look like Sandy will hold these first- and second-place titles for long.

Damages are still being tallied from the one-two punch of this year's storms in August and September.

Hurricane Harvey (downgraded to a tropical storm shortly after it made landfall) brought an unprecedented deluge to southeast Texas in late August, dumping more than a year's worth of rain in just over four days. Cedar Bayou, Texas, received a record 51.88 inches. Catastrophic flooding covered the region, and the waters lingered for many weeks in some areas.

Above: This home in Bayhead was "only" knocked off its foundation; the neighbors' houses were completely destroyed. Dr. Sue McNeil and colleagues from the University of Delaware (a CAIT UTC consortium partner) conducted surveys in 2014 and late 2015 to capture how various factors—including infrastructure restoration—influence residents' attitudes over the course of recovery from a major disaster. *Photo: New Jersey Governor's Office/Tim Larsen.*

Less than two weeks later, on September 10, Hurricane Irma hit the Florida Keys with sustained winds near 140 mph. Thankfully, Irma was somewhat smaller and faster-moving than Harvey. The storm first traveled northwest, then swung inland again and slowly lost steam. Still, its high winds and violent bands of rain raked the entire length of the state, knocking out power for more than half of Florida's residents, according to Florida Power & Light. Even as Irma weakened to a tropical depression as it zigzagged northward, it brought storm surges, flooding, damaging gusts, and scattered tornadoes to the Florida panhandle, Georgia, and South Carolina.

Hurricane Sandy and these two fierce storms are literally powerful reminders that it's important to research, record, and understand multiple aspects of how communities are impacted

>> p6

and recover from disasters so we can effectively allocate resources to repair and restore infrastructure, and, hopefully, better prepare for the future.

Superstorm Sandy pummeled communities up and down the East Coast at the end of October 2012, but the destruction was particularly jaw-dropping in coastal areas of New Jersey (where the storm made landfall) and New York.

In 2014, associate professor Joseph Trainor from the Disaster Research Center at the University of Delaware, and Alex Greer, a grad student at the time, designed and conducted a survey of residents in one Jersey Shore town to gauge and document the recovery process after Hurricane Sandy. UDel is a CAIT National UTC consortium member.

Trainor and Greer chose Sea Bright, a municipality perched on a sliver of barrier island just south of Sandy Hook and the Gateway National Recreation Area. According to the 2010 census, the population was 1,412 mostly white residents, about 15 percent of whom were over the age of 65. Median household income was $78,688. This demographic profile is representative of many small communities along the Mid-Atlantic coast.

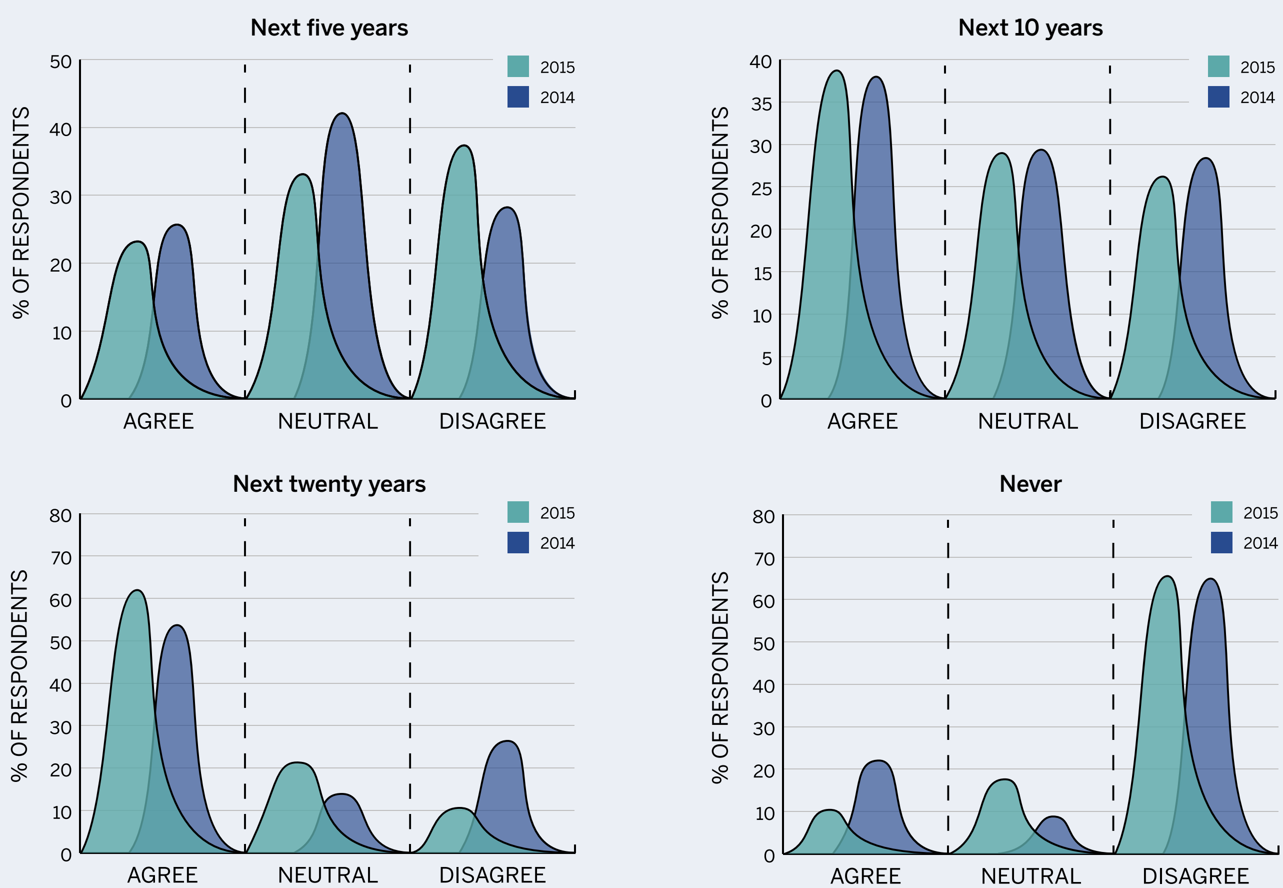
Following the 2014 survey, Dr. Sue McNeil, professor of civil and environmental engineering at UDel, wanted to capture how various factors impact residents' attitudes over a prolonged recovery, so she surveyed the people of Sea Bright again in late 2015. The goal was to compare and contrast her data with the earlier study and see what it revealed. CAIT funded the follow-up project under the consortium's UTC research activities. Qiuxi Li, a quantitative and qualitative social research specialist, helped McNeil implement the survey and analyze responses.

The timing of the two the surveys was deliberate. Since the rate of recovery varies from town to town (in some cases block to block) and programs for financial support are closing or have undergone changes, a gap between surveys longer than 12 to 16 months could miss significant events. Together, the summer 2014 and late 2015 survey provide a rich, time-series data set that gives us interesting insights into the relationships among households, transportation infrastructure, and policy. Ideally the study would be repeated every 12 to 18 months to best capture possible causal relationships and patterns.

"The basic idea is that the decisions you make about repairing infrastructure are influenced by the demand for the infrastructure," said McNeil. "If a community is going to rebuild, then the demand will be higher, hence you need to maintain and improve the infrastructure to a greater extent than for a community from which people are relocating. The household decision—'Do I stay or do I leave?'—is not well understood. But we do know from other research that it

Risk perception

Residents were asked to gauge the likelihood that a storm similar to Sandy would affect Sea Bright in the next five years, 10 years, 20 years, or never. The survey indicated their perception of risk did not change dramatically between early 2014 and late 2015.



Right: Just northwest of Sea Bright in Union Beach, Hurricane Sandy ripped this home off its foundation and deposited it in a nearby marsh. The survey by McNeil and her colleagues sought data on how infrastructure restoration influences communities' ability to recover from traumas like this. *Photo: FEMA/Sharon Karr.*

fluctuates depending on how attached residents are to that place, the availability of support services, demographics, and other such factors."

Survey participants provided information on estimated damage to their homes in dollars; status of repairs; whether or not they had flood insurance; and their qualitative assessment regarding extent of damage to their homes and the community overall.

Residents of small communities, such as Sea Bright, are strongly anchored by a sense of place and belonging. They had very different experiences in terms of the amount of damage and disruption they experienced, their access to resources, and their interactions with organizations that are critical in the recovery process. The responses underscore that "no one size fits all."

Restoring transportation infrastructure is widely recognized as an important element of short-term recovery, just as reconstruction of the built environment and other long-term recovery tasks rely on having a functional transportation system in place. However, we know very little about the role of transportation infrastructure condition and performance in influencing homeowners' decisions about whether or not to rebuild.

One previous UTC research project provided a snapshot of damage immediately after Hurricane Sandy and another recorded recovery at one distinct point in time, almost two years after the storm. By resurveying previous study participants, McNeil's project aimed to better understand how residents' decisions evolve over time.

In 2014 (two years after Sandy), only 62 percent of respondents' homes had been replaced or repaired; 14 to 17 months later, it had risen to 83 percent. That clearly shows progress is being made, but it has been slow and the process has been burdensome and complex.

Most of the work happens on a local level. However, residents very often must depend on state and federal resources that they do not fully understand. According to the survey, they are finding the recovery process lengthy and confusing; many expressed dissatisfaction with both programs and organizations, describing the administrative bureaucracies as "a nightmare." Amid the obstacles and frustrations, frequently it is residents' commitment to the community that keeps them from fleeing.

Responses to McNeil's survey suggest that symptoms of anxiety and depression are not pervasive, but they clearly do exist. Some people reported that the stress of reconstruction and restoring "normalcy" has been taking a toll on their health. A majority indicated they would move in the event of another Sandy-like storm, which suggests the limits of people's patience and perseverance wears thin the longer that recovery drags on. At the same time, responses indicate those limits have not yet been reached, since the community's demographics are steady and perceptions of risk have not significantly changed. (See figure on the opposite page.)

>> p10

Left: A portion of roof is removed during demolition of a home swept from its foundation. The project was managed under FEMA's Public Assistance Waterways Debris Removal Program. *Photo: FEMA/Sharon Karr.*

Another beast comes to Rutgers

Meet T-Rex. This awesome, unique piece of equipment is a high-force triaxial shaker used to simulate earthquakes and to do structural forced-vibration testing. It came to CAIT as part of an NSF project that is examining dynamic soil interaction as it pertains to our entire built environment.

The **Natural Hazards Engineering Research Infrastructure program at the University of Texas at Austin** (NHERI@UTexas) brought T-Rex to Rutgers for a two-day structural testing workshop it cohosted with CAIT. The program included a field demonstration of T-Rex on a bridge in Hamilton, New Jersey.

CAIT thanks the whole **NHERI@UTexas** team for bringing this “ground-breaking” technology to New Jersey for the workshop. We also thank **New Jersey Department of Transportation** for helping us identify a bridge and for facilitating the day’s field testing.

Look for a full article on the project in the next issue of *Transportation Today*.

Photo: ©Drew Noel Photography/Rutgers CAIT.

p7 You ain't seen nothin' yet

A puzzling contradiction like this could possibly be teased out over a longer-term study.

The decision to stay and rebuild rather than relocate is, in fact, influenced by the extent of damage to infrastructure and the level of disruption caused by that damage. The hope is that relationships among this study's qualitative data, various damage assessments, and other existing data and models will help us better understand if strategic, effective, and efficient investments in transportation infrastructure that meets the needs of communities can make them more resilient.

"Resources matter," McNeil says. "We are just beginning to understand these relationships."

More on the web:

- To read the survey questions and results of McNeil's study, go to cait.rutgers.edu/files/CAIT-UTC-063-Final.pdf
- The National Weather Service has thorough accounts, tracking, and statistics for severe U.S. storms. Go to **www.weather.gov:**
  - Add **/crp/hurricane_harvey** to the end of the URL for Hurricane Harvey info
  - Add **/okx/HurricaneSandy** to the URL for Hurricane Sandy info
  - Add **/mob/Katrina** to the URL for Hurricane Katrina info
- How disaster costs are estimated is explained by NOAA National Centers for Environmental Information at www.ncdc.noaa.gov/billions ■

Above: Hurricane Sandy caused widespread damage to infrastructure and personal property. The scene on this street on Long Island, buried in sand and strewn with debris and vehicles, was typical in many neighborhoods. *Photo: FEMA/ Andrea Booher.*

notable news >> recognition, announcements & events

Rising star researcher

CAIT research associate Dr. Mohammad Jalayer's hard work and engagement in professional activities and organizations are getting him noticed. One recent example: he received the Institute of Transportation Engineers (ITE) Rising Star Program Award at the Joint ITE/CITE 2017 Annual Meeting and Exhibit, held July 30–August 2 in Toronto, Ontario.

ITE is an international community of transportation professionals comprising more than 14,000 engineers, planners, consultants, educators, researchers, and technologists from more than 90 countries. The Rising Stars Program identifies young people who show promise as "next generation" leaders in transportation. It is designed to recognize members under the age of 35 who have already made an impact, demonstrated leadership, and have implemented innovative techniques to solve transportation problems. Each annual Rising Stars Class consists of representatives from ITE's 10 U.S. districts.

In 2016, Jalayer was the first-place winner of the National Highway Safety Information System (HSIS) Research Paper competition, which is jointly administrated by the Federal Highway Administration and ITE.

He is currently co-PI on a New Jersey Department of Transportation project with Dr. Peter Jin that will identify and establish metrics, guidelines, and deployment strategies needed to monitor traffic signal performance in real time, working within the constraints of existing infrastructure and NJDOT resources. Transportation agencies are using statistical evidence to quantify and evaluate traffic signal operations because optimal signal efficiency can reduce congestion, improve safety, save fuel, and cut emissions.

In addition to his research, this year Jalayer served on the technical program committee for the 2017 International Conference on Architecture and Civil Engineering, held August 23–25 in Guilin, China, and on the scientific committee for the 2017 Road Safety and Simulation International Conference in The Hague, Netherlands, October 17–19.

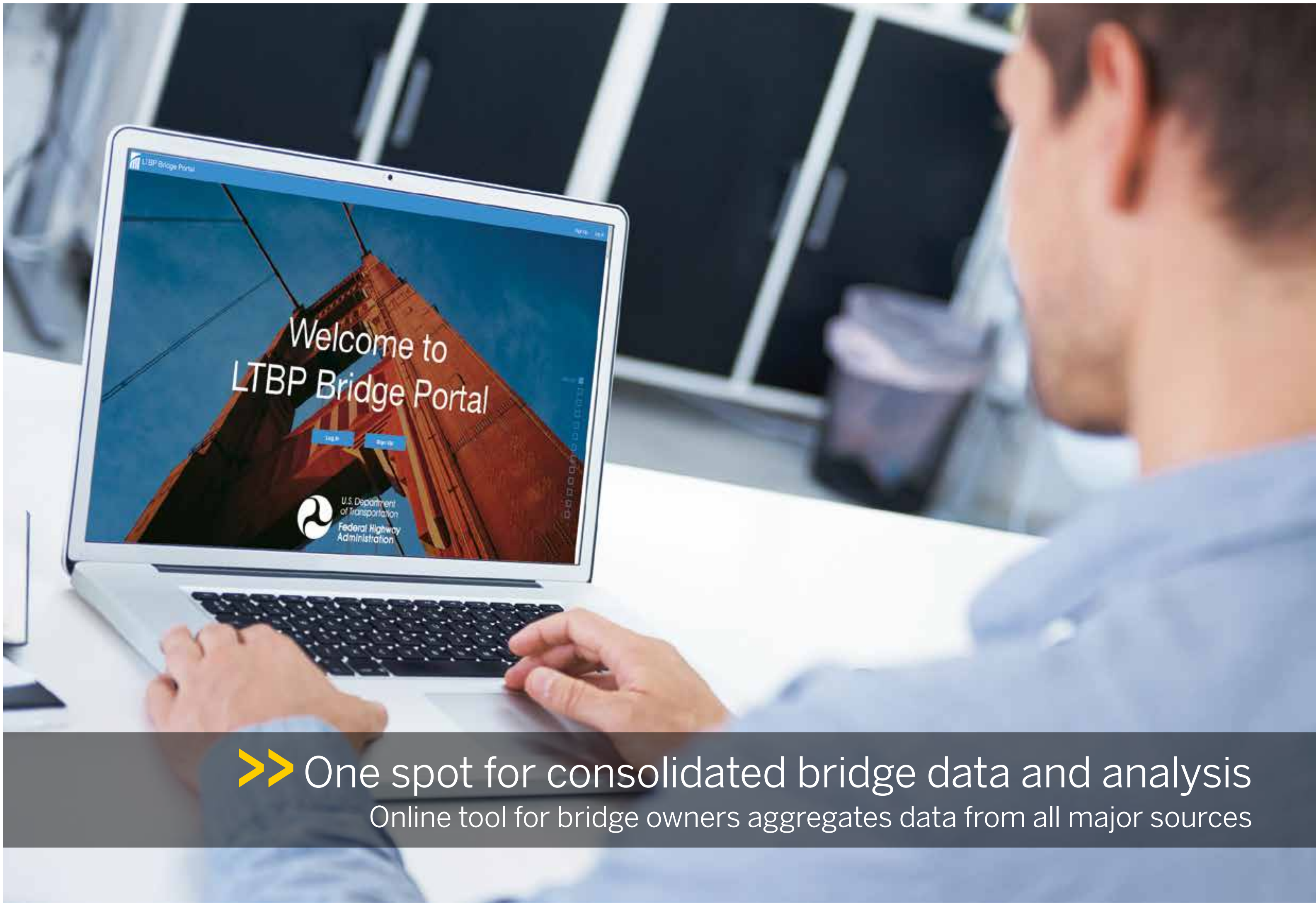
In the first months of 2017, Jalayer published three peer-reviewed journal articles having to do with motorcycle and wrong-way crashes, and nine peer-reviewed conference proceedings, also dealing with roadway safety, crash modeling, and crash prevention.

He serves on the editorial boards of the *Journal of Safety Studies, Journal of Sustainable Development of Transport and Logistics,* and *Journal of Civil and Environmental Engineering,* and is a technical reviewer for more than a dozen other professional journals.

Jalayer is an associate member of ASCE T&DI Transportation Safety Committees; a member of ITE, ASCE, and ATSSA; and works with TRB standing committees on safety data, analysis, and evaluation; highway safety performance; roadside safety design; access management; and intelligent transportation systems.

He received a doctorate in civil engineering from Auburn University in 2016. ■

Photo: Courtesy ITE.



One spot for consolidated bridge data and analysis

Online tool for bridge owners aggregates data from all major sources

Imagine you're a state bridge engineer tasked with upkeep and operation of dozens or even hundreds of structures. How would you collect information on the age, repair history, design, and traffic volumes on each asset to calculate maintenance needs for your inventory over the next five years? With a tight budget, how would you make the tough calls on which bridges to fix now and which could wait? And where would you find all the data to back up your decisions?

Agencies faced with these difficult choices rely on multiple resources to identify priorities for preservation and necessary bridge rehabilitation. There are enormously useful databases out there, such as the National Bridge Inventory—but no single source to find comprehensive bridge performance data. Until now.

The LTBP Bridge Portal aggregates all the data sets bridge owners would previously have had to access one by one. The portal is the only one-stop resource that consolidates 34 years of historical data on all the major characteristics and relevant biographical information influencing bridge performance for more than 611,000 U.S. bridges: design, age, dimensions, elevation, weather data, traffic data, weigh-in-motion data, maintenance/repair records, and more. This online tool was created at CAIT in partnership with the FHWA Long-Term Bridge Performance (LTBP) program.

Above: An all-student programming team hired by CAIT LTBP program manager Hooman Parvardeh created this comprehensive tool for bridge performance data and analysis that consolidates 34 years of data on 611,000 U.S. bridges. It is fast and powerful, yet so intuitive that lay people can use it.

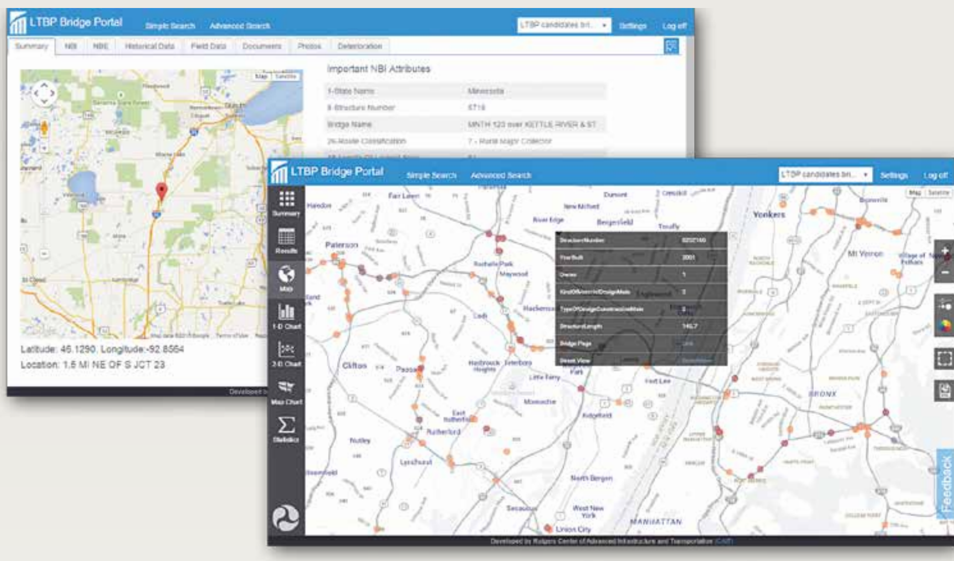
Fast, powerful, and exhaustive data delivery

The LTBP Bridge Portal can do simple or advanced queries using built-in filters, or, it can perform detailed searches based on users' specified criteria. No matter how complex or geographically broad the query is, the portal delivers tailored results at lightning speed—usually in less than one second.

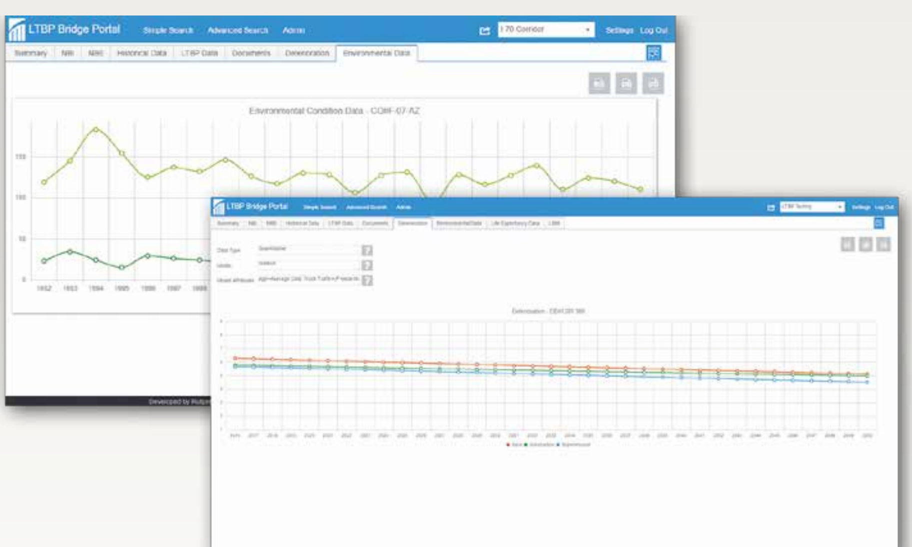
An example query might be: How many bridges in Virginia, Maryland, and Delaware are at least 100 feet long, are 30 to

>> p12

Users enter a query using a wide range of built-in filters, and the tool shows comprehensive results that can be viewed on Google Maps®. Users can customize the color and size of bridge markers according to chosen attributes, define a subset by drawing around the desired area, and zoom in on specific bridges.



Portal users can examine results on a macro level to identify patterns and trends, or hone in on a specific bridge—even zooming in to street views and photos of the bridge when available. Individual bridge records in the LTBP Bridge Portal can contain more than 120 data fields.



Beyond amassing data from multiple sources, the portal offers environmental information and powerful analytical tools, including deterioration models.

35 years old, and have average daily traffic volumes greater than 7,000 vehicles? How many of those bridges received a "poor" condition rating for at least 30 percent of the deck upon last inspection? How many are steel girder construction versus box girder? What is the inspection history for each bridge on I-95 in those states?

Even if you know where to look, sifting through multiple databases to extract all that information could take hours. Comparing/contrasting bridge attributes and locations, analyzing individual bridges, or seeing patterns within the results would be arduous. In the end you'd have results, but not necessarily a good picture of the data to communicate to others.

Expansive capabilities that don't sacrifice usability

The LTBP Bridge Portal is powerful and highly customizable, and it offers options not available in any one data set it draws from. Its intuitive web environment is so simple that lay people can use it, and if you're new to the app or need to review the features, a built-in guided tour will show you what is available and how to use it.

The portal's deceptively simple user interface and data visualization capabilities really outshine any other bridge performance tool available. Query results can be displayed in 2D or 3D charts and graphs, as map graphs, or in a GIS interface that superimposes the data on Google Maps® and can display up to 150,000 bridge markers. Results then can be exported as Excel, PDF, or KML (Google Earth) files.

Each individual bridge record is made up of more than 120 data fields. Users can customize the color and size of markers to correlate to particular attributes or other criteria, view regions by drawing a circle or freehand polygon, and define subsets within a region.

In the tool you can examine results on a macro level to identify patterns and trends, or hone in on a specific bridge—even zoom in to street views and photos of the bridge when available. Queries also can be saved to access, edit, and review later.

But far beyond just providing and filtering amassed data, the portal also puts a number of analytical tools at users' fingertips to help them make and support critical decisions about where to invest limited bridge maintenance and repair funds.

Packing that much functionality into a single tool while keeping it simple and fast was no small feat. Considering CAIT project manager Hooman Parvardeh built the tool using only student programmers makes it doubly impressive.

When asked about the toughest aspect of making the portal, Parvardeh said, "As we incorporated more data sources and added functionality and features, the application became heavier and more complicated. Working with that huge data volume and complexity, it wasn't easy to maintain a simple, user-friendly front end. It also was very difficult to keep the speed up. Our goal was to have the system return search results in less than three seconds, no matter how broad or complex the query."

Parvardeh is in the process of spreading the word about this resource. The team has held webinars for more than 10 state agencies and presented at a number of conferences, including the 2016 AASHTO Subcommittee on Bridges and Structures meeting. "The feedback from state DOTs has been tremendously positive," Parvardeh said. "I'm confident we delivered a product that was beyond FHWA's initial expectations."

A tool that will grow to meet future needs

The LTBP Bridge Portal is continually evolving. For instance, in the past several months, developers added a function to calculate deterioration models that are formulated from a wide range of historical data and produced using multiple methods, including Weibull and Markov.

CAIT and FHWA intend for that kind of growth to continue as data expands and additional features are needed.

Future enhancements already in the works include incorporating bridge legacy data mining and improving the ability to upload multiple LTBP collected data sets from hundreds of bridges. The CAIT team is mining legacy data that potentially has an influence on performance, but may not be readily available in state databases. Parvardeh explained, "Not all states have every data point or characteristic of a bridge in a database. For example, they may not have girder spacing in their database, but they do have it in the bridge plans. The team is seeking out this information, doing statistical analyses to determine a particular factor's significance, and incorporating it into the LTBP database if appropriate."

Ali Maher, CAIT director and principal investigator on LTBP, says, "The portal is a powerful research tool for exploring bridge performance on many levels. It provides insight that supports data-driven decisions when it comes to deterioration modeling, preservation, and safety of our nation's highway transportation assets. As long as there's a need for that knowledge, we'll continue to hone this tool to deliver it." ■

LTBP Bridge Portal: One stop for comprehensive bridge data

The LTBP Bridge Portal currently includes these major data sets, which are updated and expanded regularly.

National Bridge Inventory (NBI) historical data from 1983 through 2016; updated annually.

National Bridge Element (NBE) data for some states. Since 2015, most states have submitted NBE data to FHWA, and it is subsequently added to the portal.

LTBP Program inspection and field data. This typically includes data from nondestructive evaluation (NDE) testing, visual inspections, load ratings, and material sampling. This data set will grow as the program progresses.

LTBP Program legacy data mining. This comprises a wealth of information, including data extracted from bridge plans, inspection and maintenance reports, and construction and preservation cost records.

NOAA weather station data. LTBP portal developers parsed weather data to show the number of freeze-thaw cycles and the number of snowfalls for bridges within a certain radius of in-place weather stations.

About LTBP

In 2008, the Federal Highway Administration (FHWA) launched its largest and most robust bridge research endeavor: the Long-Term Bridge Performance (LTBP) Program. It is envisioned as 20-year study of U.S. bridges—our transportation network's most critical links.

The Center for Advanced Infrastructure and Transportation (CAIT) at Rutgers, The State University of New Jersey, was competitively selected as the primary university partner on LTBP and, for the last nine years, has been working with FHWA to provide a more detailed and timely picture of bridge performance.

LTBP Bridge Portal contributors

The LTBP Bridge Portal was developed at CAIT in partnership with FHWA's Long-Term Bridge Performance Program.

Rutgers CAIT

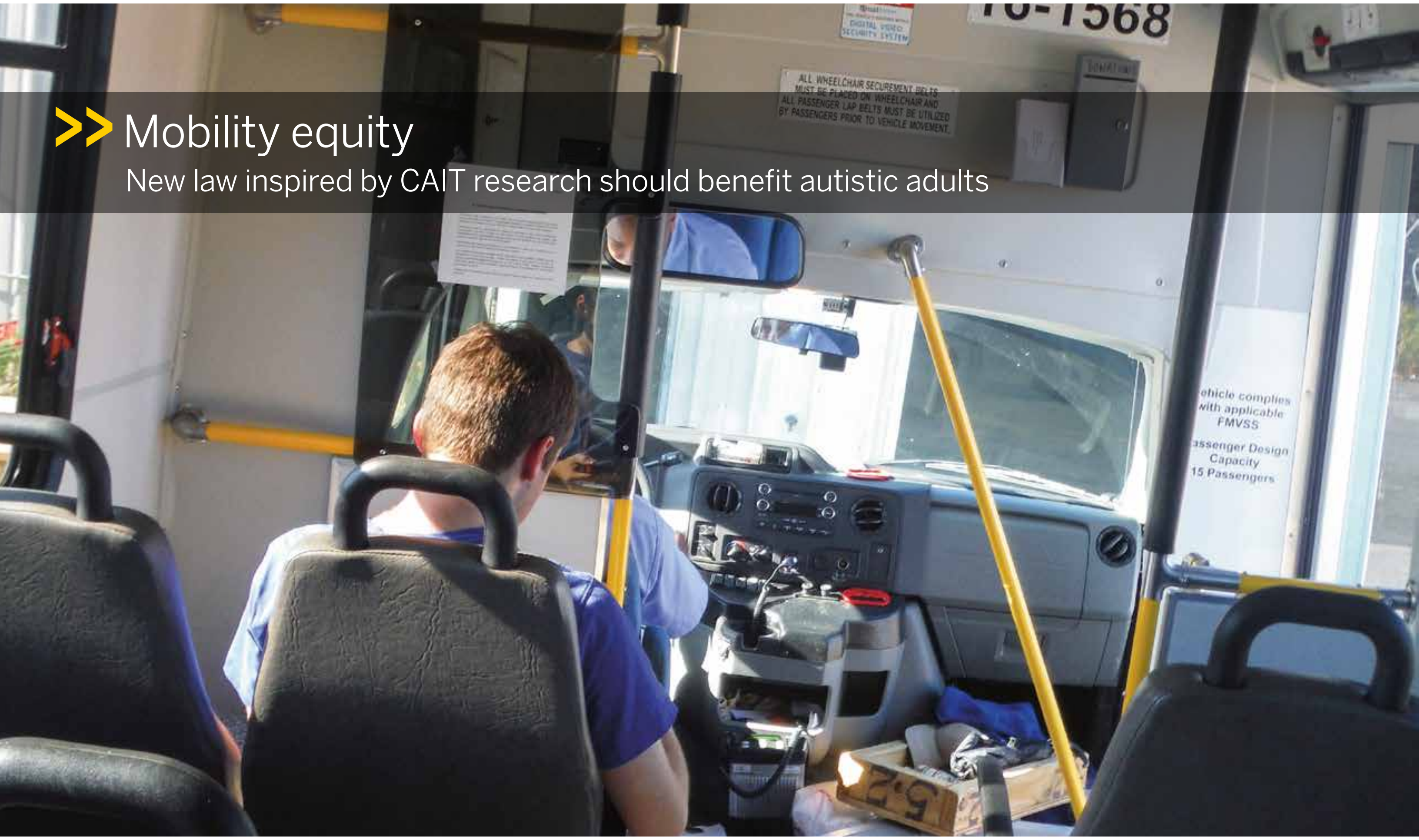
Ali Maher, Principal Investigator
Hooman Parvardeh, CAIT LTBP Program Manager
Ayush Jain, Lead Developer

FHWA Turner-Fairbank Highway Research Center

Hamid Ghasemi, LTBP Program Leader
Robert Zobel, LTBP Program Coordinator

>> Mobility equity

New law inspired by CAIT research should benefit autistic adults



In May 2017, Governor Chris Christie signed legislation that takes an important step toward meeting the transportation needs of New Jersey citizens with developmental disabilities.

The legislation was inspired by the final report from a two-year research project led by CAIT project manager Dr. Cecilia Feeley and co-authors Dr. Devajyoti Deka and Andrea Lubin from the Voorhees Transportation Center (VTC), and Melanie McGackin of Autism Family Services of New Jersey.

The new law establishes an 11-member task force to study and make recommendations that would expand transportation options for adults with autism spectrum disorder (ASD). In the General Assembly, Majority Leader Louis Greenwald and Democratic representatives Pamela Lampitt, Daniel Benson, Marlene Caride, and Nicholas Chiaravalloti sponsored the bill. Senate authors and sponsors were Paul Sarlo, Bob Gordon, and Nilsa Cruz-Perez.

For 70,000 adults with autism in New Jersey, getting to and from work, medical appointments, continuing education classes, and social or community activities is not as simple as hopping on a bus or even summoning Uber.

"Since many individuals with autism spectrum disorder cannot drive, making sure they have access to transportation is crucial," said Lampitt (D-Camden/Burlington). "This [task force] creates a space for [all the stakeholders] to come together and devise ways to make the system more equitable."

The Rutgers project surveyed more than 700 adults with autism and their families about challenges they face finding suitable transportation. The researchers hosted listening sessions with 25 public and private organizations and held focus groups with adults on the spectrum and their parents/guardians. These groups said their "dream" transportation option would be reliable and frequent; pick them up near home; and operate beyond "9 to 5" to make socializing easier. They also wanted training that empowered them to use public transit alone and confidently. Both parents and adults with ASD lamented that transportation instruction wasn't offered in school.

"Unfortunately, we found that safe mobility skills are not often taught during young adults' school transition or covered in their individualized education plans (IEP)," said Lubin, senior research specialist at VTC.

Most research participants had some knowledge of public transit, but few had used the scant services available. Instead, 68 percent had parents or friends drive them; 72 percent of caregivers said they missed some of their own activities to provide rides; and 72 percent of adults with ASD said they miss things they want to do because no one is available to give them a ride when they need it. Clearly the arrangement is inconvenient and sometimes frustrating for everyone involved. But more importantly, it also stands in the way of autonomy for an adult with ASD.

Twenty-eight percent of adults with ASD said they walked when they needed to go somewhere. This too can be problematic; walking not only severely limits range of travel, it also is often impractical, and sometimes even unsafe.

Deka noted, "The study found that many adults with ASD lack basic safe-walking skills, which contributes to isolation because they don't feel free to move around." The survey showed 54 percent had trouble crossing roads, and 45 percent had difficulty judging distances between themselves and oncoming vehicles.

Benson (D-Mercer/Middlesex) pointed out that solutions need to go beyond systems and services: "[It also means] making sure these men and women receive the training they need to walk or use public transportation [and] reach their destinations safely."

The final research report, *Detour to the Right Place: A Study with Recommendations for Addressing the Transportation Needs and Barriers of Adults on the Autism Spectrum in New Jersey*, details these and other obstacles that those with developmental disabilities—and their caregivers—face just trying to conduct normal daily activities. The report offers recommendations for overcoming barriers that frequently hobble this population's ability to live on their own, hold a job, or have full, rewarding social experiences.

"There is a growing need in our state for transportation services [that allow] adults with ASD to assert their independence and improve their quality of life," said Greenwald (D-Camden/Burlington). "This task force will … hear what adults with ASD need, and address those needs accordingly."

"As the parents of adults with ASD [get older] and perhaps become less able to care for their kids, they begin to worry," said Chiaravalloti (D-Hudson). "[A goal] of this task force is to make sure adults with autism can live independently and to give their parents some peace of mind."

The Mobility and Support Services Task Force will consist of commissioners from six New Jersey State departments plus the Secretary of Higher Education and four experts from the public. The group will submit a report to the governor and the legislature within one year of its formation.

The original Rutgers research project was supported with funding from the Governor's Council for Medical Research and Treatment of Autism. ■

More on the web: The final research report and executive summary are available for download at cait.rutgers.edu/autism-survey

Photo: Cecilia Feeley/Rutgers CAIT.

>> transportation today

Transportation Today is published by the Center for Advanced Infrastructure and Transportation (CAIT) at Rutgers, The State University of New Jersey.

Editor-in-Chief and Art Director: Allison Thomas

Design and production: Rizco

For questions or comments, or to submit a story, contact a.thomas@rutgers.edu.

CAIT is a National University Transportation Center sanctioned and supported by the U.S. Department of Transportation's Office of the Assistant Secretary for Research and Technology.

www.facebook.com/RutgersCAIT

infraculture >> transportation & culture

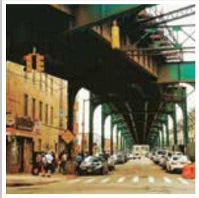

allison969


buggin.out


dailyoverview


felecool


huggingtreessince54


kowa_mag_netic


mancunadian


matthewjosephphoto


metabolist


nicanorgarcia


pjmarcellino_film


u_spalding

#transportation #infrastructure

Hashtags on Instagram indicate photographers everywhere are still showing their love and appreciation for bridges, roads, railroads, ports, energy systems, and all other types of infrastructure. As of this writing, here are image totals tagged with a few favorite infrastructure words:

#city	49,495,990	#port	2,868,736
#train	27,099,276	#concrete	2,338,362
#road	13,320,335	#shipping	1,863,252
#bridge	12,064,208	#tunnel	1,637,344
#subway	4,611,618	#transportation	639,474
#highway	3,343,751	#infrastructure	158,484

YOUR PHOTO HERE!
Use hashtags **#infrastructure** and **#rutgerscait** on your Instagram photos, and we'll publish our favorites in the next issue of *Transportation Today.*

RUTGERS
Center for Advanced Infrastructure
and Transportation

Rutgers, The State University of New Jersey
100 Brett Road
Piscataway, NJ 08854-8058

>> cait.rutgers.edu