On October 14, 2015, the public was invited to meet the BEAST at an event that included the ribbon-cutting ceremony, dedication, and tours of the completed facility. More than three years in the making, the BEAST epitomizes CAIT’s commitment to maintaining and improving the condition of infrastructure and finding ways to reduce costs. People are taking notice of the BEAST even more for its potential than its size. The USDOT Office of the Assistant Secretary for Research and Technology profiled the BEAST in its March 2015 UTC Spotlight, and during the summer the Senate Committee on Commerce, Science, and Transportation came to see it firsthand. Most who have heard about the BEAST agree it could be the next breakthrough in the fight to reduce bridge life-cycle costs, extend their life spans, and save billions of dollars in the long run.

It is a truly unique facility that can quantitatively measure stresses caused by the environment, traffic, and winter maintenance deicing treatments using full-scale bridge sections as test specimens. The BEAST will give us real data from real bridges regarding how materials, preservation
Successes of 2015 galvanize future work on resilience, life-cycle cost reduction, and state of good repair

When CAIT became a national University Transportation Center, we took a longer and broader view of our role. We have the advantage of being amid an “infrastructure petri dish” of the most dense and complex transportation network in the nation—as well as some of the oldest in-service structures. This combination of density, age, and exponentially growing demand means the center’s research in state of good repair will always be needed in this region and beyond. And, to ensure our research is relevant and that we are developing useful products, we know it is crucial that we listen to our customers.

That is precisely how the idea for the BEAST came about. Through our work on FHWA’s Long-Term Bridge Performance Program, we talked to state DOTs and asset managers across the country. What we heard from them time and again was that the feedback loop for data on bridge performance was too slow; they needed answers now about the best ways to extend the life spans of our nation’s bridge inventory.

So we started figuring out how to do that; to get quantitative data on what materials and preservation methods stand up better over time, and get it in a fraction of the time it takes in the field.

As you may have heard by now, the solution we designed and constructed is the world’s first accelerated testing facility for full-scale bridges: the BEAST. Our cover story recounts how we went about achieving this, why the BEAST has the potential to save billions of dollars in the long run, and what legislative and transportation leaders had to say at the celebration of what we hope will be a new era in bridge research.

Though the creation and launch of the BEAST was intense and consuming, it was only one of many groundbreaking initiatives we engaged in.

In this issue of Transportation Today, you also can learn about CAIT’s recent airport pavement research (page 26) and how we are helping communities make urban streets safer for all road users (page 13).

For the first four days in June, CAIT hosted researchers hailing from Alaska to Florida at the Council for University Transportation Centers (CUTC) annual summer meeting (page 21). We invited our colleagues to “join us in Jersey” and delivered four days of energizing, productive information exchange, technical tours, and networking.

CAIT “imported” a dredge material processing technology from Japan and demonstrated it in the United States for the first time (page 5). Pneumatic tube mixing is a “one-stop” method of processing and stabilizing contaminated sediments that are normally too soft to be used for construction fill.

We have a progress report on a new technology platform to survey and map gas pipelines, providing the basis for a risk assessment tool that will help recognize potential pipeline issues and hopefully help avoid incidents like the March 2015 explosion in New York City (page 23).

These and other activities are evidence of CAIT’s ongoing commitment to state of good repair, safety, and collaboration with colleagues and stakeholders across and beyond the United States.

Now, new challenges

Listening to customers and developing tools that can be put to use immediately is what has guided our efforts to date, and it is how we will now tackle two of the nation’s most prevalent challenges: infrastructure resilience and reducing lifecycle costs.

Every time you turn on the news, there is at least one report of severe weather around the world. Persistent drought in the American West led to record-breaking wildfire season last summer and fall (more than 9.9 million acres burned, 30 percent above the average for the last 10 years). Conversely, elsewhere there were torrential rains and floods (the most deadly and costly weather events in the United States). In Boston, more than 90 inches of snow—double its annual average—fell last winter in only 23 days, yet 2015 was the warmest on record.

Indications are that extreme weather and natural disasters are becoming more frequent and more intense. Infrastructure is threatened in all these events; how to prepare better and recover faster is essential.

In early December, CAIT held a workshop on infrastructure resilience that covered vulnerabilities, systems interdependence, and emergency priorities. Discussions focused on potential solutions and tools, especially those that could be put into practice in the next two to five years. We will report on the outcomes in the near future.

Although everyone was happy to see the new long-term transportation legislation signed into law in December, the $305 billion FAST Act will not reverse the trend of shrinking funds and rising costs that has become especially acute in the last 15 years. As deterioration of the country’s transportation and energy systems accelerates with age, it is more important than ever that we find ways to optimize maintenance and repair costs, and squeeze every last drop of service life out of our assets.

To this end, in January 2016 we will announce the date for a workshop on this subject and invite everyone in the transportation community to participate in developing a roadmap that identifies the greatest challenges, clarifies metrics for infrastructure investment, and puts forth potential solutions for optimizing life-cycle costs.

Stay tuned.

Guests of honor cut the ribbon at an event celebrating completion of the BEAST. Left to right: Kevin Womack from the USDOT Office of Research, Development, and Technology, Assemblyman John Wisniewski, School of Engineering Dean Thomas Farris, FHWA New Jersey Division Administrator Robert Clark, and CAIT Director Ali Maher. Photo © A. Thomas/Rutgers CAIT.
techniques, and rehabilitation treatments stand the test of time by compressing decades of the wear and tear our highway bridges endure into a just a few short months.

More than 100 people who attended the October 14 dedication were frankly amazed. Guest of honor Assemblyman John S. Wisniewski, chair of the New Jersey Assembly Transportation and Independent Authorities Committee, joked it would have been better to meet the BEAST on Halloween, but conceded the date was close enough. In his opening comments he said, “Having this kind of tool to help us understand how to allocate what are admittedly scarce dollars is one of the most important things we can do, not only for the long-term safety of our transportation infrastructure, but also when we are convincing our constituents and colleagues of the need for investment.

“At Rutgers, we have the tools necessary to make sure our investments are wise, prudent, and will last a long time … now we can make [an even more] convincing argument that investing in infrastructure is the right thing to do.” — Assemblyman John Wisniewski

“Here in New Jersey, at Rutgers, we have the tools necessary to make sure our investments are wise, prudent, and will last a long time … now we can make [an even more] convincing argument that investing in infrastructure is the right thing to do,” Wisniewski told the crowd.

School of Engineering Dean Thomas Farris brought good wishes on behalf of the Rutgers–New Brunswick Chancellor Dick Edwards and President Robert Barchi, who were unable to attend. Farris said they both would have spoken about Rutgers’ commitment to enhancing the student experience. Farris said, “What is very special about CAIT to me is its serious involvement of our students in its research, whether it’s out on the road inspecting bridges or now getting to participate in operating the BEAST.”

Current state of affairs

Many people have trouble grasping exactly how deteriorating bridges affect their lives until a bridge is closed between where they are and where they want to go. That is perhaps the clearest way to drive home the urgent need to address the health of our infrastructure.

The average age of bridges in America is 42 years, and already nearly one in four is deemed functionally obsolete or structurally deficient. The current U.S. bridge inventory comprises more than 610,700 structures and, in just 10 years, 44 percent of them could be 55 years old or older. Furthermore, FHWA calculates that presently more than 30 percent of bridges have

ON THE COVER: The BEAST loading carriage exerts up to 60,000 pounds of vertical force at 20 mph around the clock—a moving load roughly equal to a dump truck rolling across the bridge specimen 17,500 times in a 24-hour period.

Above: The “big yellow bridge eater” lives on Rutgers Livingston Campus, adjacent to CAIT’s asphalt pavement labs.

Photos © Drew Noel Photography/Rutgers CAIT.
already exceeded their 50-year design life. That means the dilemma we face now will become ever more daunting in the future.

Rebuilding all the U.S. bridges rated structurally deficient—more than 63,300 in all—is impossible in both practical and financial terms, so we need to extend the service life and performance of the bridges we’ve got now. That means we have to identify and quantify the best rehabilitation and preservation techniques, materials, and management strategies that will maximize the life span of existing assets—and make sure the new bridges we build last 100 years or more.

But how do we know the choices we make today will still be the right ones 10, 20, or even 30 years from now? Everyone wishes there were a crystal ball that would show us how materials and structural components will perform in the future, especially bridge owners who have the weight and responsibility of the public’s safety and millions of taxpayer dollars resting on their shoulders.

“A key challenge bridge owners contend with daily is the question of how to upgrade and extend the life of our assets, and just as importantly, how to prioritize their choices,” said Patrick J. Natale, who recently retired as executive director of the American Society of Civil Engineers and is now vice president for business strategies at Hatch Mott MacDonald.

“With the BEAST, CAIT and its partners have created a way to scientifically project future performance based on reliable, real data, providing engineers and managers with much-needed information on which they can base these crucial decisions,” Natale said in an interview for the BEAST documentary.
However, the Clean Earth, Inc., dredged material processing facility along the Hackensack River in Kearny was the perfect site for CAIT to demonstrate a sediment processing and stabilizing method being used in the United States for the first time: pneumatic tube mixing (PTM).

CAIT Director Ali Maher—principal investigator who is leading a team of researchers from CAIT, Clean Earth, Inc., Tokyo Institute of Technology, and JAFEC USA, Inc.—hosted an event on August 26, 2015, to share early findings of a two-year project funded by the New Jersey Department of Transportation (NJDOT) Office of Maritime Resources.

The research is evaluating PTM as a technique for stabilizing fine-grain sediments—in this case, sediment dredged from the New York/New Jersey Harbor. The material for the study was contaminated with by-products of the area’s 100-plus-year history of intense industrial activity, which left behind pollutants such as heavy metals and pesticides.

Representatives from the Army Corps of Engineers, New Jersey Department of Environmental Protection, U.S. Environmental Protection Agency, and several private engineering firms attended the event at Clean Earth’s Kearny facility. Clean Earth—one of the East Coast’s largest processors of contaminated soil, dredged sediments, and hazardous and nonhazardous soils—provided the site, equipment support, and much of the labor for this successful pilot project.

One-stop solution

“This is a rapid ‘one-stop’ process for environmentally stabilizing, transporting, and placing reclaimed contaminated dredged materials, soft soils, and mud for a wide range of structural and nonstructural applications,” explained Maher, as he stood before...)
the invited guests on a surface consisting entirely of solidified dredged material processed and placed with the PTM system.

Dr. Robert Miskewitz, associate research professor with Rutgers Department of Environmental Sciences and a CAIT-affiliated researcher, said, “Our demonstration showed that PTM is a viable tool that has never before been used in the United States.” Miskewitz noted the material used for the study was dredged from the Arthur Kill tidal strait—one of the Port of New York and New Jersey’s major navigational channels.

A change from business as usual
Historically, sediment dredged from the many miles of engineered waterways in the New York/New Jersey Harbor was unceremoniously dumped offshore at a site called the Mud Dump. Strict environmental laws severely curtailed this practice in the early 1990s, limiting open water disposal to only the cleanest sand and clays. This brought on a dredging crisis in one of the nation’s busiest ports.

In 1996, recognizing the critical role that New Jersey and New York port facilities and terminals play in the region’s economy, then-governors George Pataki (R-NY) and Christine Todd Whitman (R-NJ) signed the Joint Dredging Plan for the Port of New York and New Jersey. (See sidebar on the history of beneficial use of dredge material in New Jersey/New York on page 8.)

The next step was to develop technologies that addressed sediment and erosion control, dredging, transportation, processing, decontamination, and beneficial use, as well as the eventual remediation of contaminated harbor sediment.

“The biggest early challenge was where to put contaminated dredge material,” NJDOT project manager W. Scott Douglas told attendees at the PTM event. “[At the time], we were forced to quickly come up with something if we were to keep the second-largest port in the United States open.” For Douglas, the PTM system offers a solution to this challenge that has economical and environmental benefits.

According to The Processing and Beneficial Use of Fine-Grained Dredged Material: A Manual for Engineers, which is an NJDOT publication that CAIT contributed to, “… the reality of disposal options without beneficial use is that they are not sustainable; by definition, any disposal site will eventually fill up.”

For this and other practical and ecological reasons, NJDEP and NJDOT encourage

Upcycling using the Pneumatic Tube Mixing process

1. The dredged sediments are moved to the site on a barge or pumped directly from the waterway bed.

2. If there is debris in the dredged material, it is placed in a holding pit and then screened before entering the mixing system.

3. The screened material is pumped to a mixer and cement or a different stabilizer is added to the material.

4. The sediment-cement mix agitates and mixes as it travels through a pipe to the pneumatic tube mixer, where blasts of compressed air break the “mud” into alternating air/mud plugs, then is driven through the delivery pipe, mixing further still.

5. The processed dredge material is then applied directly where fill is needed. It hardens into a stable surface in a few days.
beneficial use of processed dredged material applications as diverse as highway construction, sculpting golf courses, and restoring wildlife habitat.

As of 2013, more than 13 million cubic yards of material dredged from the New York Harbor has been processed and reused in brownfields reclamation and development of condominium complexes, shopping malls, and recreation sites. Some examples in the area include the Susquehanna Bank Center in Camden (220,000 yd³), mine remediation in Tamaqua, Pennsylvania (550,000 yd³), Jersey Gardens Mall (800,000 yd³), Philadelphia Airport (1.2 million yd³), and the Bayonne Golf Club (5 million yd³).

**A “better mousetrap” from Japan**

PTM was developed in Japan for large-scale projects using fine silt and clay sediments. The system works both onshore and offshore. It is ideal for large-scale stabilization and reclamation projects such as construction of new harbors and artificial islands, but it is equally effective for moderate-scale operations and those that need to rapidly stabilize contaminated soft sediment. It was used for the offshore reclamation and construction of the Tokyo Haneda International Airport Runway, for airport construction in Osaka, Nagoya, and Hong Kong, and for other harbor projects throughout East Asia.

Before PTM, special mixing vessels or on-land processing plants were needed to amend fine-grained dredged materials, which untreated are too “soft” for construction projects.

PTM’s single integrated system greatly simplifies the mixing process. It can use existing pneumatic conveyance equipment and ordinary concrete pumps, and provides several advantages over mechanical conveyors. Pneumatic tubes can be laid to bend around existing equipment, structures, or landscape features, making the system more flexible than a mechanical conveyor, which is typically straight. Pneumatic conveying systems also occupy less space, usually have fewer moving parts, and are totally enclosed, so they help contain dust and airborne contaminant particles during processing and placement of the material.

**Turning waste into a commodity**

Miskewitz says PTM offers clear economic and environmental advantages. “Perhaps the greatest benefit is the large reduction in material transport and handling costs,” he noted. “And in situations where the sediments are hazardous, PTM also reduces workers’ exposure to harmful contaminants.”
Meeting an old challenge: The story of beneficial use of dredge material in New York and New Jersey

The history of what to do with dredged materials in the New York metro area took a turn in 1995 when the New Jersey Office of Maritime Resources (OMR) was established and charged with implementing the innovative dredged material management policies in response to a dredging crisis in the New York/New Jersey Harbor.

Restrictions that eventually led to closure of the “Mud Dump” site off Sandy Hook in the early 1990s jeopardized the plan to deepen the Port of New York and New Jersey entrance channels by 50 feet. Suddenly without its centuries-old practice of open-water disposal, the region found itself at a loss for options to manage millions of cubic yards of contaminated estuarine mud.

OMR was responsible for implementing the Joint Dredging Plan for the New York/New Jersey Harbor and for administering the projects in the 1996 Dredging and Harbor Revitalization Bond Act, signed by then-governors George Pataki (R-NY) and Christine Todd Whitman (R-NJ).

In 1997, the New Jersey Department of Environmental Protection (NJDEP) published a landmark management and regulation manual that was incorporated in the New Jersey Coastal Zone Management Rules (N.J.A.C. 7:7E). A key management decision deemed dredged material a resource, not solid waste. That important distinction opened up a new regulatory program that ensured the safe management of dredged material.

The New Jersey Legislature mandated that NJDOT and NJDEP encourage beneficial use and provide legal protections for dredged material placed in the state.

The 1997 Brownfields Law (N.J.A.C. PL 1997 Chapter 278) encouraged beneficial reuse for remediation of contaminated properties by providing incentives to entities that willingly cleaned up their property and agreed to use dredged material in the process.

In 2000, OMR was permanently housed in the New Jersey Department of Transportation and continues to lead state activities in dredging and dredged material management policy and planning.

Below: At Clean Earth’s dredged material processing facility in Kearny, New Jersey, CAIT did a demonstration project using pneumatic tube mixing for the first time in the United States. Aerial via Google Earth.
A stabilizer, such as cement slurry, is added. The dredged material and additive pass through the mixer and into a pipeline; blasts of compressed air break the material into alternating “plugs” of dredge material and air. This plug flow prevents clogging and allows the material to move through the tube more quickly.

As the plug flow passes through the pipeline, the soft dredged material and stabilizing agent are agitated and further mixed together, then dispensed directly to the final placement area.

The CAIT-NJDOT PTM project started in February 2015 and will continue through January 2017. The next phase of the project will be longer-term analysis to determine the strength of the stabilized material and if contaminants leach over time as the material continues to cure, and if so, to what degree.

**PROJECT PROFILE**

**Title:** Utilization of Pneumatic Tube Mixing Technique for Processing and Stabilization of Contaminated Soft Sediments in the New York/New Jersey Harbor

**Site:** Clean Earth, Inc. dredge processing site, Kearny, New Jersey

**Material spec:** 4,500 yd³ anticipated volume

**Source:** Arthur Kill (USACE Site AK4)

**Main contaminants:** Polycyclic aromatic hydrocarbons, metals, and pesticides

**PTM production rate:** 300 to 500 yd³ for demonstration purposes (can be significantly ramped up in non-demo application)

**Field operation duration:** Two months

**Laboratory study:** The laboratory study consists of a comprehensive evaluation of raw and stabilized dredged material chemical and physical (geotechnical) characteristics for the purpose of designing the field experiment and also developing field QC specifications.

**Field study:** Plots for testing various Portland cement concentrations were established in the field. Both shallow (1 foot) and deep (6 feet) test plots were filled with stabilized dredge materials. Cores and other in situ testing is being conducted to determine physical and chemical characteristics of the material so the suitability of the method can be assessed.

**Project sponsor**
New Jersey Department of Transportation
W. Scott Douglas, Program Manager

**Research team**
Rutgers CAIT, Ali Maher, Ph.D., Principal Investigator
Tokyo Institute of Technology, Masaki Kitazume, Ph.D.
JAFEC-USA
Clean Earth, Inc.

Above, top: Shallow (1 foot) and deep (6 feet) plots for testing various Portland cement concentrations were filled with stabilized material. When the tubes on the right are extracted, the cores inside will be tested to determine physical and chemical characteristics of the material and validate PTM as a suitable method for this particular application.

Above, middle and bottom: The soft dredged material, combined with a stabilizing agent (in this case Portland cement), is agitated and mixed together as the slurry passes through the pipe and is then dispensed directly to the final placement area.

*Photos © Drew Noel Photography/Rutgers CAIT.*
The RABIT™ was created at CAIT in partnership with FHWA to gather condition data for bridge deck assessments. It simultaneously deploys multiple NDE tools autonomously, creating a picture of deterioration and other problems quickly, safely, and accurately.

At an event on Capitol Hill in July 2015, ASCE debuted Infrastructure #GameChangers, a new report and associated website that profiles products, materials, and discoveries that could impact the outcome of the “infrastructure game” nationwide.

“It’s important for us to celebrate the many accomplishments in the profession, and GameChangers is a way to do that,” said ASCE Executive Director Thomas W. Smith III.

RABIT™ was called on to do a preliminary assessment of the bridge deck as part of a study to plan an extensive rehabilitation. At that time, the team scanned three lanes and presented condition data to the Bureau of Eastern Federal Lands Highway Division.

Then, in mid-March 2015, the bureau asked the CAIT team to return and scan all six lanes of the 2,163-foot-long structure so they could get a comprehensive picture of the entire bridge deck. RABIT™ deployed its full suite of NDE tools to assess how this historic landmark was faring.

Working about four hours each day to minimize disruption for the average 68,000 vehicles that cross the bridge each day, the team gathered an immense volume of data and completed the assessment in just six days. Consistent with the investigation in 2013, they found widespread deterioration of the deck, especially debonding of the asphalt overlay, and serious deck delamination and reinforcement.
corrosion. The GPR survey described a significant percentage of the deck area as deteriorated and/or highly corrosive. In fact, results showed only 10 percent of the deck area could be described as good.

Based on data from the impact echo survey, almost 80 percent of the deck was delaminated or had overlay debonding; a high percentage of the deck—from about 30 percent to more than 60 percent—was already in a serious or severe condition.

Unfortunately, before repairs could be initiated, in April 2015 inspectors found the structural steel was corroding faster than anticipated and closed curbside lanes in both directions, four feet of the adjoining sidewalks across the drawbridge span, and imposed a 10-ton load limit indefinitely for the entire length of the bridge, eliminating most bus traffic, which impacts both commuters and tourists.

On June 1, 2015, Congresswoman Eleanor Holmes Norton (D-DC), ranking member of the Highways and Transit Subcommittee, introduced the Save Our National Parks Transportation Act, which calls for a program to fund construction, reconstruction, or rehabilitation of nationally significant federal lands and tribal transportation projects.

Norton noted that underfunding of the National Park Service, which currently receives only $240 million for transportation projects nationwide, has led to a deferred maintenance backlog of $11.5 billion. “Sites like the Memorial Bridge must be 100 percent funded by the federal government and not part of any state’s allocation. The federal government, the Congress of the United States to be specific, has been shameful in simply not allocating funds,” Norton said.

As of this writing, repairs to the bridge are under way. The updates are adding new support beams, resurfacing the roadway, and strengthening the sidewalk. The first phase in the repair program is expected to cost $2.5 million, but the full $250 million rehabilitation could take three years or more to complete.

Had the findings of inspectors, data that RABIT™ and the CAIT team gathered, and pleas for funding from Borders and the NPS been acted on earlier, some of the cost and inconvenience of the bridge closure may have been avoided or reduced.

For most of us, getting to work, going shopping, or heading out for a night on the town with friends isn’t a big deal. We jump in our cars, hop on a bus, or maybe call Uber. But for 70,000 adults with autism in New Jersey, it’s not that simple.

CAIT and the Voorhees Transportation Center (VTC) at Rutgers engaged in a two-year study to gather information on the challenges New Jersey adults with autism spectrum disorders (ASD) face getting to and from their jobs, medical appointments, continuing education classes, and social and community activities.

A culminating 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 researchers’ findings, results of a statewide survey, and a list of recommendations for removing obstacles and improving transportation options for adults with ASD.

Principal investigators Cecilia Feeley from CAIT and Devajyoti Deka from VTC coauthored the report. “Very little has been written about the transportation issues encountered by adults with ASD,” said Feeley. “Our study sought to gather much-needed information on the challenges New Jersey adults with ASD face as they pursue employment, continuing education, and other critical opportunities.”

The research team surveyed more than 700 adults with ASD and family members about their transportation habits and challenges; conducted structured interviews and listening sessions with 25 public and private organizations that serve the autism community; and staged six focus groups—four groups consisting of adults with ASD and two with parents and guardians.

**Answers from the source**

The initial survey covered participants’ current transportation use, their knowledge of public transit, and what skills and training—or lack thereof—would give them more options and improve their mobility and independence.

While most participants had some knowledge of public transportation, survey responses indicated few of them used the available options. Instead, 68 percent said they got rides from parents or friends; 72 percent of the caregivers miss some of their own activities to provide rides; and 72 percent of the adults with ASD miss some activities due to people being unavailable to give them rides. Clearly, the arrangement not only increases dependency, it is equally inconvenient for both the drivers and the passengers.

Twenty-eight percent of adults with ASD participating in the survey said they walked where they needed to go. This too can be problematic: Walking is not always practical or safe and severely limits traveling range. Feeley noted, “The study findings demonstrate that many adults with ASD lack basic safe walking skills, which contributes to isolation and lack of mobility.” The survey indicated 54 percent had trouble crossing roads, and 45 percent had difficulty judging distances between themselves and oncoming vehicles.

**Focus groups**

After conducting surveys on current public transit use, researchers broke participants into small focus groups to discuss transportation needs and desires. Participants from the focus groups described their optimum transportation service as one that offers reliable and consistent service, crosses county borders, picks up customers close to their homes, and offers travel instruction to empower adults with ASD to safely and independently use public transit.

Parents noted the need for drivers to be well trained in transporting adults with ASD. Adults on the spectrum desired service frequency in both peak and off-peak hours so they could engage in more social events and outings.

Both adults with ASD and their caregivers lamented that transportation instruction and safe pedestrian skills were not offered in schools, nor included in students’ Individualized Education Plans (IEPs). “Unfortunately, what we found is that transportation and safe mobility skills are not often taught during young adults’ school transition period or covered in IEPs,” said VTC contributing researcher Andrea Lubin. “After graduation, many individuals on the spectrum and their families struggle to find feasible transportation options.”

**Moving forward to improve transportation options**

Based on extensive discussions and the survey results, researchers developed 15 recommendations to improve access and transportation services to adults with ASD. Though the recommendations are New Jersey-specific, Feeley believes they would work for stakeholders in similar regions nationwide. A few key goals are:

- Incorporate transportation and pedestrian skills into structured education before people with ASD “age out.”
- Establish a center to investigate and implement strategies that improve mobility for people with developmental disabilities.
- Provide training to vehicle operators and others who interact with people on the autism spectrum.
- Research the relationship between employment and transportation accessibility.
- Capitalize on technologies—such as smartphone apps or Google Glass among others—as tools to help people with autism travel more safely and confidently.

More on the web: Download a summary of the study or a copy of the full report at cait.rutgers.edu/autism-survey.
According to the New Jersey Department of Transportation (NJDOT), in 2013 there were over 280,000 crashes on the state’s roadways. Of those, over 500 resulted in fatalities and more than 60,000 caused injuries.

Two CAIT programs, the New Jersey Local Technical Assistance Program (NJ LTAP) and Transportation Safety Resource Center (TRSC), began offering statewide RSAs at no cost to municipalities and counties in 2009, thanks to funding from NJDOT and the Federal Highway Administration (FHWA). Since then, CAIT and its partners have been part of many RSA success stories and helped steer communities to millions of dollars in funding for roadway improvements that increase safety.

Last year, FHWA recognized CAIT’s RSA program with a National Roadway Safety Award in the planning, development, and evaluation category.

When CAIT’s award-winning RSA team hits the road, it’s serious about safety; some would say even fixated on reducing costly crashes, injuries, and fatalities. Their approach? Help communities identify safety issues and steer them through a process that leads to effective improvements and ends up benefitting everyone: pedestrians, cyclists, drivers, and transportation officials.

Making safety house calls
CAIT coordinates safety teams that come to you. Atlantic City, Jersey City, Newark, Passaic, and Paterson are among the cities that have taken advantage of the collaborative roadway assessments. Conducted by an independent team of multidisciplinary professionals, RSA site assessments address wide-ranging issues including pedestrian and bicycling safety, intersection analyses, speed factors/speed management, signage visibility, and human factors. Navigating road safety issues is a three-step process. First, the RSA team partners with the region’s MPOs, such as the North Jersey Transportation Planning Authority (NJTPA) or the South Jersey Transportation Planning Organization, and conducts a screening to pinpoint high-crash locations that are regional safety priorities. During this network screening process, NJDOT’s award-winning Plan4Safety software, developed and maintained by Rutgers, is used to provide the team with comprehensive, incisive crash data analyses based on more than a decade’s worth of records on every crash in the state.
Next, the team joins forces with the local roadway owner, law enforcement, community groups, and other stakeholders to conduct “eyewitness” inspections. They combine those on-site observations with the data analysis to develop appropriate options for safety solutions and improvements.

Finally, the RSA team submits a final report that recommends high-quality, cost-efficient, implementable long- and short-term countermeasures that can significantly impact the safety of drivers and pedestrians alike. This final report can be used to support a municipality’s applications for funding to implement the RSA recommendations.

**RSA spurs $3 million in funding for Jersey City improvements**

Roughly 19,000 cars a day travel on Jersey City’s Kennedy Boulevard, which, between 2008 and 2013, had a crash average that was 6.7 percent higher than that of Hudson County overall. Photo © Ashlee Espinal/The Jersey Journal.

In September of the same year, the Hudson County Division of Engineering partnered with CAIT to pull together a team that could conduct a daylong RSA assessment of the 10-block area stretching from Communipaw Avenue to Montgomery Street on Kennedy Boulevard.

The NJTPA subsequently awarded a total of $3 million for intersection improvements along this section of the boulevard. Even before the team’s final report was submitted in December 2014, Hudson County roadway owners had agreed to all of its recommendations, implementing improvements such as push buttons, signage, and pothole repairs. Other recommendations will be considered during the design phase, with construction slated to begin later this year.

**Reducing risks on Newark roadways**

With nearly 300,000 residents and thousands of commuters and students, Newark is New Jersey’s largest city. As such, it has more than its fair share of congested corridors with higher-than-average crash rates. Density brings an increase in the number of cars and trucks, which, in turn, increases potential conflicts that can occur among vehicles, cyclists, and pedestrians.

“Over the past few years, we have performed several Road Safety Audits that have resulted in us receiving local safety funds to make the necessary safety improvements,” said Jack M. Nata, manager of the City of Newark’s Division of Traffic and Signals. “The City of Newark has embraced Road Safety Audits as a means of bringing together various stakeholders in order to address safety issues at our most dangerous intersections and corridors.”

These RSAs have resulted in grants of more than $1 million to address high-crash intersections at Park Avenue and 4th Street, and Martin Luther King Jr. Boulevard between 7th and Crane streets.

In March 2011, Caminos Seguros, a division of Hispanic community organization La Casa de Don Pedro and the County of Essex, called on the RSA team to assess the Park Avenue and 4th Street intersection. The organization’s request was in response to innumerable complaints from concerned residents about the lack of safety at this busy, sometimes dangerous, intersection.

Park Avenue and 4th Street is in an area buzzing with activity. Light rail and bus stops, gas stations, car washes, restaurants, and retail stores all attract plenty of vehicular and pedestrian traffic—and unfortunately the crashes that go along with urban bustle.

Safety engineers from TSRC teamed up with planners from Rutgers’ Voorhees Transportation Center, Newark police officers, and representatives from NJTPA, NJ Transit, NJDOT, New Jersey Division of Highway Traffic Safety, and FHWA to tackle the problem.

The team’s investigation revealed that between 2007 and 2010, Park Avenue and 4th Street was the scene of 29 crashes that resulted in 24 injuries. Four of these crashes involved pedestrians, but a larger number of the incidents were rear-end collisions. This information gave the team a clear starting point.

The field investigation revealed multiple safety issues: signal timing and obstructed sight lines, roadway visibility, lack of pedestrian crosswalks and signals, and an unmarked lane merge.
The RSA team’s final report included recommendations such as installing pedestrian countdown signals, a “no turn on red” sign, high-visibility crosswalks, improved merger signage, and back plates to increase visibility on all traffic signals. With guidance on potential funding sources and perseverance by the city, these improvements were designed and completed by August 2014.

Elsewhere in Newark
The October 2011 RSA evaluation of Martin Luther King Jr. Boulevard between Crane Street and 7th Avenue resulted in 64 recommendations. Roadway owners agreed on 60 of the 64. Traffic signal overhauls, roadway alignments, sidewalk replacements, and improved signage are among the changes completed by the end of 2014, thanks to funding from the NJTPA Local Safety Program.

Four-lane Bergen Street, home to Newark’s University Hospital, is one of the city’s busiest emergency services corridors—and one of its most hazardous. Data from 2010 to 2012 showed a higher-than-average number of crashes at two intersections near the hospital.

During a July 2013 RSA, the team found 28 safety issues at the intersections of Bergen Street and 12th Avenue, Cabinet Street, and West Market Street that could be readily mitigated with short- and long-term countermeasures such as updated crosswalk and pavement markings, longer pedestrian signal times, a new bus shelter, and a mountable pedestrian refuge island in a newly marked crosswalk. The NJTPA Local Safety Program has included funding for them in a $902,964 project for federal FY2015.

Further up the road
Main Avenue (CR 601) in the City of Passaic has the dubious distinction of being Passaic County’s #1 mile for pedestrian crashes. Ranking crashes from 2008 to 2010, this corridor was also Passaic County’s #1 highest 1/10-mile section: crosswalks at Main Avenue and Monroe Street were the scene of 12 walking injuries and 35 crashes.

In September 2011, an RSA team conducted an evaluation of seven intersections along the avenue that present particular hazards for pedestrians. Corridor-wide recommendations included installations such as curb ramps, re-striping, pedestrian push buttons, signal upgrades, countdown timers, sign and roadway markings, and modified access points to a parking island.

Passaic County roadway owners agreed to nearly all of the team’s suggestions. The project received $1,227,000 in funding for federal fiscal year 2014 from the NJTPA Local Safety Program, and construction is scheduled to begin by this summer.

A stretch of Paterson, New Jersey’s Main Street (CR 601) has a significantly higher percentage of injury and fatal crashes than the rest of Passaic County. A March 2014 RSA targeted 10 intersections along Main Street (CR 601) in Paterson for numerous safety improvements.

The City of Newark has embraced Road Safety Audits as a means of bringing together various stakeholders in order to address safety issues at our most dangerous intersections.”

— Jack Nata, Division of Traffic and Signals Manager, City of Newark
stresses relating to complex deterioration processes without waiting decades. We knew we had to close that gap,” says Maher.

FHWA New Jersey Division Administrator Robert Clark echoed that when he addressed the audience at the dedication. He said of the current paradigm in the transportation industry, “To be frank, in the past the bridge community didn’t have the ability to—and this is key—accurately predict performance of these structures. Engineers can only infer or take very educated guesses on the anticipated life of the bridges they design. The good news is that was yesterday; today, we have the BEAST.”

“This facility is a critical part of establishing a successful long-term bridge program, and it will significantly improve the state of practice nationally and internationally,” Clark said.

**Compressing time: science fact, not science fiction**

The BEAST’s relentless traffic loading—up to 60,000 pounds total applied through two closely spaced axles—runs 24/7 and inflicts stresses roughly equal to a dump truck rolling over the deck 17,500 times each day. Its “freeze-thaw” rapid-cycling temperature fluctuations from 0 to 104 degrees Fahrenheit, and salt brine application put the test sample through 15 years’ worth of seasonal changes in just six months. Extensive calculations indicated the frequency and intensity of these environmental and load inputs could induce and fast-forward aging as much as 30 times.

Dr. Franklin Moon, a respected bridge expert and member of Rutgers civil engineering faculty as of January 2016, reiterated the importance of compressing time such that it will give us answers almost immediately, compared to field testing.

“Many bridge owners are increasingly frustrated by the slow progress toward more durable bridges. The fundamental challenge relates to the many years required to understand and evaluate the durability of materials within bridge systems,” Moon explained. “The current approach to this kind of research is to do trial implementations and observe in-service performance over decades. This slow feedback loop means the enormous advances in new materials that have emerged over recent years can’t be effectively harnessed.

“For example, let’s say a DOT implements a new type of deck overlay that really outperforms conventional approaches,” Moon added. “By the time this superior performance becomes clear—perhaps decades later—the company that produced it may be out of business or may have changed the mix, and meanwhile several generations of potentially superior materials would have been ignored. Given the current state of our bridges, and their rates of deterioration, we simply don’t have the luxury to take a ‘wait and see’ approach.”

Moon has collaborated with CAIT on many large-scale projects, including LTBP, the International Bridge Study, the Bridge Resource Program, and development of new technologies for bridge assessment and repair.

He is the technical director for the BEAST.

**Building a first**

Kevin Womack, director of the USDOT Office of Research, Development, and Technology, said at the October gathering, “In research, it’s not often you get to go from concept all the way through to seeing something get built. That’s the research pinnacle—to see an idea put into practice.” In his former position at Utah State University, Womack worked closely with CAIT on LTBP and other research. He now heads up the University Transportation Centers program.

After years of examining the theory and triple-checking calculations for the BEAST, CAIT embarked on finding a company with the engineering experience, capabilities, and facilities to build it.

That’s when Applied Research Associates (ARA), an international scientific research and engineering firm, joined the team.

Spread: Rigging the main beams May 21, 2015. The heavy-hauling operation to move the BEAST involved 11 trucks, special rigging, and a rear-steering dolly. In all, Izzi Trucking & Rigging, with the help of High Transit, moved 85 tons of steel components and 17 tons of ancillary equipment more than 300 miles. **Photo ©Drew Noel Photography/Rutgers CAIT.**
The problem with making something that’s never been built before is, obviously, the lack of precedent. ARA’s Vertek Division based in Randolph, Vermont, was hired to help CAIT work through the countless engineering questions involved in creating the BEAST.

For example, what was the most efficient and consistent way to apply the moving load, and how could we move it end-to-end and laterally across the deck? How could we build a chamber big enough to enclose a bridge and maintain stringent environmental parameters without blowing the budget for the whole project? How could the device be flexible enough to accommodate a variety of superstructures and work equally well for all of them?

These questions, and many, many others—from broad design issues to what kind of fittings were best for the brining system—had to be answered to keep the project moving.

The BEAST’s sheer size alone was, literally, a big issue. David Timian, ARA senior vice president and manager of the company’s Automation and Geosciences Sector, said it was the biggest machine ARA had ever built, as well as the first environmental chamber on that scale.

“This project took up our entire 67,000-square-foot design, fabrication, and assembly shop,” said Timian. “We had a core team of five people working on it full time, plus consultants and subcontractors at various stages.

“We had to move our HVAC systems and build a section of driveway behind the building so trucks could maneuver these huge components,” Timian explained. “After the beams were put together with bracing, we knew they would be too wide to get back out of the building, so we had to widen the opening of our 17-foot existing bay doors to 19 feet just to get it out of the shop,” Timian said.

The main assembly for the loading device consists of two parallel steel “hollow-tube” beams 7 feet tall by 120 feet long. The beams rest on support towers affixed to rail carts, allowing operators to lift and roll it out of the way when lowering test specimens into the chamber. The beams and support towers weigh 112,000 pounds. The rolling carriage, which hangs from the beams, can exert a load up to 60,000 pounds on the test specimens; it weighs 10,000 pounds, and the winch that pulls the apparatus weighs about another 15,000 pounds.

Timian also commented that ARA felt like a real partner in the process, not just “hired help.” He said, “When a problem arose, we would sit down, put all the cards on the table, and figure it out as a team. So, even though we faced a lot of engineering ‘puzzles’ while building the BEAST, the fact that we could put our heads together and work through it made solutions a lot easier to come up with.”

On LTBP, we interacted with state DOTs, bridge experts, and researchers across the country … it became apparent that we had to accelerate deterioration to get them answers quickly and, in order to accurately represent what would happen to structures in service, testing on full-scale samples was key.” — CAIT Director Ali Maher
After 17 months creating the BEAST, Timian and his team also had to figure out the best way to move the massive components from ARA’s plant in Vermont to the BEAST’s permanent home adjacent to the CAIT pavement labs on the Livingston Campus.

Moving the BEAST involved a heavy-hauling operation with several complicated moves and special equipment, not to mention know-how. Stephen Izzi Trucking & Rigging was responsible for getting the main components of the BEAST from ARA’s shop to Rutgers. Izzi enlisted High Transit, LLC, to haul the beam assembly.

The moving operation for all the BEAST components took 11 trucks, special rigging, and a four-axle rear-steerable dolly as part of a 10-axle combination for the 120-foot beams. All in all, Izzi Trucking & Rigging was responsible for moving 85 tons of steel components more than 300 miles and 17 tons of ancillary equipment. The beam assembly load required state police escorts and special permitting in every state it traveled through. Once it arrived on site, working with Eddie Shinn Cranes, Izzi used a 120-ton crane and another 100-tonner to rig the BEAST’s support towers onto specially designed rail carts, then lift the 100,000-pound beam assembly from the truck and place it on the support towers with absolute precision.

Left, top and middle: The BEAST’s moving load runs 24/7, inflicting stresses roughly equal to a dump truck rolling over the deck 17,500 times per 24-hour period. Rapid-cycling temperature changes and applying salt brine put the test sample through 15 years of seasonal changes in just six months. Together, they fast-forward aging as much as 30 times. Images by Industrial Motion Art.

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“The BEAST in motion” at the October 14 dedication. About 100 onlookers snapped photos as the BEAST loading device zipped back and forth over two temporary structural steel beams installed so the team could test and calibrate the equipment prior to the first experiment. Photo © Drew Noel Photography.
A BEAST for bridge owners’ burdens

“The BEAST beats up on bridge samples so we can make bridges in our transportation network better endure the forces that are constantly beating on them,” said Andrés Roda, CAIT research engineer in charge of the BEAST construction and now its operations manager.

“Our country’s infrastructure is incredibly important. It’s what carries us from place to place, transports goods, and keeps businesses moving. The interstate system built in the 1950s allowed us to see the beauty of America coast to coast. Now, here we are, 60 to 80 years later, and we need to take care of it,” Roda says.

Moon agrees. “The United States spends about $5 billion per year on bridge deck deterioration and other rehabilitation. But if you look at the total cost of those bridge assets, it’s north of $2 trillion. So, $5 billion might sound like a lot, but it’s less than one percent of the value of those assets.”

“The BEAST will allow us to look at the materials and methods we’re using and make smarter decisions about how we build our new bridges, how we take care of the bridges that are here, and how we move forward with creating 21st century infrastructure,” Roda explains.

“The data we get from it will provide insight, help manage expectations, and give bridge owners empirical evidence to optimize their decisions and maximize the life cycle of bridges throughout the country—all sooner than ever imagined,” he adds.

“The American Society of Civil Engineers’ Industry Leaders Council not long ago put forth the challenge to reduce infrastructure life-cycle costs 50 percent by 2025. We need a lot of creativity in order to meet that goal. We believe there are several ways to address this, including innovation, resilience, performance-based standards, and life-cycle analysis. Innovations CAIT has developed, like the BEAST and RABIT™ [bridge assessment robot], are the tools we need to do business,” said Pat Natale of Hatch Mott MacDonald.

Ultimately, what the BEAST can teach us will significantly improve public safety, facilitate U.S. commerce and economic growth, and potentially save billions of dollars in infrastructure costs.
At the request of the South Jersey Transportation Organization, the 1700 block of Atlantic Avenue in Atlantic City was the scene of an April 2014 RSA. The team focused on the mile-long corridor running from Michigan Avenue to South Carolina Avenue, which has been the scene of numerous crashes involving pedestrians.

While $400,000 in funding has been allocated for improvements, work on implementing the RSA suggestions has yet to begin, according to the CAIT team.

**Street-smart safety solutions**

From the beginning, CAIT safety evaluations have helped identify and resolve high-risk road safety issues around New Jersey, and led municipalities and counties to the funds they need to put them into effect.

With the support of FHWA and NJDOT, RSA teams have recommended hundreds of cost-effective, long- and short-term safety enhancements on some of the state’s busiest urban, suburban, and rural roadways.

Clearly, the results pay off. For example, New York DOT reported crash reductions at more than 300 high-crash spots where low-cost improvements were made. These locations realized between 20 and 40 percent crash reductions depending on the exact treatments they received.

RSAs continue to prove their value across the country. For example, sites in South Carolina that implemented 50 percent or more of the RSA-recommended improvements saw a reduction in crashes and/or fatalities ranging from 12.5 to 60 percent. With those kind of results, the economic savings can be calculated between $40,000 and $3.6 million.

RSAs are saving both lives and money. That’s what we call street smarts.

More on the web: A list of RSA resources is available at cait.rutgers.edu/tsrc/road-safety-audit-resources.

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**Demonstrating research value for our UTC sponsors**

On May 14, 2015, Amy Stearns and Denise E. Dunn, UTC representatives from the USDOT Office of the Assistant Secretary for Research and Technology, Office of Innovation, Research, and Education (OST-R) had a full schedule on their daylong visit to CAIT. We gave them updates on some of the center’s most recent research and technology developments in bridge condition assessment and management, advanced pavement materials and mix design, automated nondestructive evaluation platforms and remote sensing, intelligent transportation systems, dredge management, roadway safety, and more.

Presentations covering ongoing projects in risk assessment of pipelines and rail were particularly timely, especially in view of the Amtrak derailment near Philadelphia just days before their CAIT visit, and the March 26 gas explosion that took down a large portion of a block in Manhattan.

The day included tours of our accelerated bridge-testing lab, the BEAST, and the adjacent accredited asphalt paving lab.

CAIT researchers and project managers gave demos of some new “gee-whiz” technologies that will promote infrastructure state of good repair, safety, and asset management. Demos included a UAV that will make bridge inspections easier, safer, and more thorough; THMPR, a device for measuring the load-bearing capacity and other structural integrity characteristics of bridges; a new remote-sensing platform combining lidar, GPS, thermography, and other tools that will map pipelines and provide data to support risk assessment software for utility owners; and, of course, the RABIT™ bridge deck assessment robot developed with FHWA, which won the ASCE Pankow Award for Innovation last year.

Our goal was for Stearns and Dunn to leave inspired by promising research that can contribute to maintaining and improving the country’s transportation infrastructure.

CAIT is proud to be a USDOT national “state of good repair” research center; we relish the opportunity to show how we’re focusing on projects that have national importance and will spur the next generation of technologies for infrastructure testing, monitoring, design, and management.

CAIT showed OST-R guests new technologies it has developed, including a bridge inspection UAV and the THMPR, a device for measuring the load-bearing capacity and other structural integrity characteristics of bridges. Left to right: Dr. Franklin Moon, Amy Stearns, Denise Dunn, Andrew Ellenberg, Dr. Patrick Szary, Andrés Roda, and Gordana Herning. Photo ©A. Thomas/Rutgers CAIT.
We invited our colleagues to “join us in Jersey” for informative technical tours, presentations, and networking. Attendees included around 130 senior-level university researchers and administrators, plus representatives from USDOT, FHWA, DOTs, and industry. The host UTC is chosen via competitive proposals. Among many benefits offered in Rutgers’ bid, one of the strongest is its location in the most active and diverse transportation corridor in the nation. Rutgers President Robert Barchi, New Jersey Assemblyman John Wisniewski, and School of Engineering Dean Thomas Farris welcomed the crowd on the second day of the meeting with opening remarks emphasizing the importance of transportation research. Several people said afterward that they were impressed that all three men had a thorough understanding of CAIT’s achievements and specific ongoing initiatives.

Technical tours that gave visitors an inside look at a few of the region’s most complex systems and facilities were praised as “meaningful and well-thought-out.” At the Port of New York/New Jersey outside of Newark (aka Port of Elizabeth), cutting-edge freight technology, and the sheer size and scope of operations showed visitors why, as part of the largest container port system on the East Coast, New Jersey feeds the supply chain from the Atlantic well into the Midwest. Port Authority staff provided an overview of the port, from its long history to current projects and future development.

TRANSCOM, a cooperative of 16 agencies that optimize the region’s transportation systems, demonstrated how it improves mobility and public safety by supporting its 16 agency members with design applications, interagency communication, and enhanced use of traffic/transportation management systems. Visitors observed that...
TRANSCOM is a focal point for securing federal and other sources of funding for multimodal transportation improvements.

One of the most popular tours was to the Google engineering offices in Manhattan, where the tech giant and one of its partners, SADA Systems, Inc., shared how Google is influencing our future “roads and rails” with ITS and GIS apps. As an example, the guide pointed to the City of Chicago’s success in leveraging technology to manage its transportation assets more efficiently. The tour participants left with a wealth of ideas for using Google technologies in their own research.

Another conference highlight was a maritime tour of Lower New York Harbor to see the sights, including freight terminals, several major crossings connecting New Jersey and New York City, and, of course, the Statue of Liberty. The voyage was narrated by Dr. Bojidar Yanev, NYC DOT executive director of bridge inspection and management, who is responsible for the health of 750 of New York City’s 2,000-plus bridges and tunnels. Passengers gathered around Yanev to marvel at his staggering depth of knowledge of the history, construction, and rehabilitation of the Brooklyn, Manhattan, and Williamsburg bridges and other iconic landmarks. Despite the drizzle, many people ventured out on deck to capture a photo of Lady Liberty, an inspiring sight even for locals who see it on a regular basis.

Throughout the conference, CAIT-developed technologies were on display as examples of how we are helping reduce life-cycle costs, improving safety and mobility, and keeping infrastructure in the best shape possible.

These included one UAV that can access hard-to-reach areas during bridge inspections to make them easier, safer, and more thorough, and another drone that will be used to report, record, divert traffic in the event of roadway incident. Another was a new remote-sensing platform combining lidar, GPS, thermography, and other tools that has countless applications from mapping pipelines to providing data for risk assessment software and disaster response and mitigation. Of course we showed off the RABIT™ bridge deck assessment robot developed with FHWA, which won the 2014 ASCE Pankow Award for Innovation.

CUTC guests were among the first people to see the world’s first accelerated testing facility for full-scale bridge systems, the BEAST. More than five years in the making from concept to reality, construction of the BEAST was completed about a week before the conference.

The CAIT team worked nearly two years on the extensive planning and logistics required to ensure the CUTC meeting came off without a hitch. By all accounts, it was a success.

More on the web: See a photo album of the summer meeting on CAIT’s Facebook page. facebook.com/RutgersCAIT. The meeting materials are archived at cait.rutgers.edu/cutc-summer-2015/archive.
In March 2014, two pipeline explosions occurred in our area just one week apart: one in Ewing, New Jersey, and a second in East Harlem. The two incidents together killed nine people, injured nearly 80 more, and displaced residents of at least 126 households.

It was “déjà vu all over again” when almost exactly one year after the East Harlem explosion, on March 26, 2015, another explosion in New York City destroyed much of a city block in the East Village and killed two people. Officials determined a leak from an illegal siphoning tap was the cause.

These tragedies in the New York metro region and throughout the nation strengthen CAIT researchers’ resolve to find a solution.

Last July, Transportation Today announced the Pipeline Mapping and Monitoring Project that was awarded to Rutgers civil engineering associate professor Dr. Jie Gong by the USDOT Office of the Assistant Secretary for Research and Technology. Gong, who submitted the pipeline proposal through CAIT, has been working hard since then, driven by the belief that better monitoring and risk assessment systems greatly improve the chance of avoiding destruction and loss of life.

Gong and his team have been developing a multisource remote-sensing data fusion platform for assessing the integrity of natural gas pipeline systems. Gong’s research team leverages vertical integration of spatial mapping platforms such as mobile lidar and infrared systems, airborne lidar, and UAV imaging systems, as well as advanced spatial analytics for pipeline condition mapping and assessing the likelihood they could leak or rupture. Gong aims to provide a complete, implementable solution for pipeline stakeholders to keep track of inventory and intervene where there are identified risks.

“What we’re doing with this project is not only testing the compatibility of these integrated technologies, but taking the data and preparing a threat assessment system to help decision makers direct actions where they’re most needed, optimize repair schedules, and increase safety,” explains Gong.

A USA TODAY Network investigation found that about every other day in the past decade, a gas leak in the United States has injured or killed people, and since 2004 caused about $2 billion in property damage. Recent incidents within 50 miles of CAIT are sobering reminders of the danger posed by old, faulty, or tampered-with natural gas pipelines.
Postdisaster study that sparked the pipeline project

As part of a pilot project in 2012, Gong surveyed Ortley Beach and other New Jersey communities devastated by Superstorm Sandy. He used ground-based mobile lidar to collect data that would help measure and understand damage and plan recovery from Sandy and future storms. The idea for integrating spatial sensing technologies for large-scale assessment of pipeline systems in the Pipeline Mapping and Monitoring Project was sparked during that survey, when Gong saw firsthand how soil displacement, uprooted trees, impacts from debris, scour and erosion, and the additional pressure from floodwaters during and after natural disasters can make pipelines vulnerable to damage and failure.

Gong’s team and partners from the Gas Technology Institute (GTI) kicked off the Pipeline Mapping and Monitoring Project by identifying the gaps in existing research literature that would help shape the direction of the project and ultimately maximize its impact.

In order to meet the project goal of providing new remote-sensing capabilities to assess pipeline risk, the CAIT team quickly began to test and calibrate the remote sensors and other technology they hoped to integrate into their platform, assessing the performance of each system and quantifying its operating parameters. This establishes the baseline for combining data from different remote-sensing technologies.

Key to the project’s success is integrating lidar and thermography on a mobile platform that can quickly gather fine-grained data. By September 2014, the researchers had installed integrated GNSS/INS and lidar sensors on a van, and made headway in developing and assessing the efficacy of the various components that compile, process, and analyze the data gathered by the mobile system.

Field testing and data analytics development

By the beginning of 2015, researchers had traveled to a mock town at a New York State Electric and Gas Corporation training facility where they simulated service riser and underground gas leak scenarios for infrared thermography-based gas leak detection testing.

The team also improved the scanning capability of the mobile mapping platform—nicknamed Rutgers Infrastructure Mapping, or RIM, system—by adding remote-sensing devices such as Velodyne lidar, and integrating the FARO Focus3D terrestrial laser scanner with infrared thermography.

They also developed dedicated software packages to
process sensor data and generate high-resolution geospatial data.

Thanks to these enhancements, RIM can map infrastructure and communities at “traffic speed,” capture geo-referenced infrared images for review and analysis, and display them on Google Earth.

By spring 2015, Rutgers-CAIT researchers and their GTI partners were confident they had met a critical project goal: developing a point cloud and infrared imagery analysis system able to extract data from remote-sensing systems and detect changes and anomalies that threaten pipeline integrity. They presented their research findings to the Society of Gas Operators (SOGO), a group of natural gas industry professionals.

**Back to the future**

This past summer, the CAIT researchers returned to Ortley Beach, where they again scanned the town to gather new baseline data for the risk assessment software demo. At the same time, they tested RIM’s ability to capture the precise 3D data necessary for detailed assessment of infrastructure and buildings.

“By proactively gathering baseline data before the threat of a potential natural disaster, we’ll be able to be ‘data ready’ for future extreme events,” explains Gong. “We are particularly focused on how we can use this data to gauge the integrity of gas pipelines.”

In September 2015, the CAIT and GTI announced they had successfully developed a remote-sensing-based framework for postdisaster evaluation. Leveraging remote-sensing data, this framework detects terrain changes, storm surge heights, and building damage—essential data for quantifying the potential of natural gas facilities and pipeline failures. The framework also incorporates a building damage detection program that uses pre- and postevent airborne lidar data and can automatically compute the extent of damage to individual households.

By employing existing, available tools in a new way and developing software that exploits their mutual capabilities, CAIT’s GIS-based pipeline and assessment tool kit will soon be ready to give pipeline owners and safety experts the critical information they need to prioritize repair, help restore service more quickly, and ultimately prevent devastating explosions.

**More on the web:** Stay up to date on this project at cait.rutgers.edu/pssp/monitoring/updates.
Why are some Newark runways cracking up?

Premature aging is no laughing matter when so much is riding on airport pavements

EWR runway 4L-22R carries about 220,000 flights annually; closing it for just two months during a $97 million major rehabilitation in 2014 reduced the airport’s capacity by over 15 percent.

Runway closures are no fun for passengers either. Anyone who has sat waiting for takeoff, looking down the tarmac at the long line of planes ahead of theirs can attest to that.

“It’s to everyone’s benefit to maximize the lifespan of airport pavements. It’s not a safety issue so much as it’s a congestion and financial issue. Basically, once an airport owner rehabs a runway, they don’t want to even think about it for at least 10 years,” Pavement Resource Program director Dr. Tom Bennert told us. “Rehabilitating or repaving a highway, officials can close a few lanes or divert traffic until the repair is done. There is no ‘alternate route’ when runways are out of commission, and it significantly affects the capacity of the airport,” Bennert said.

Runway ‘X’ is cracking and showing signs of accelerated aging—runway ‘Y’ looks fine. As asphalt ages, it becomes more prone to cracking, but these two runways are about the same age, see nearly identical traffic, and are paved with the same asphalt mixture specification, called P401. Why is one cracking and deteriorating while the other isn’t?

Three runways at EWR comprise over 4 million square feet of asphalt pavement. Add 12 miles of taxiways—only a small percentage of which are concrete—and that brings EWR’s asphalt total to nearly 9 million square feet. With so much riding on that vast quantity of pavement, there’s no such thing as a “minor problem.” That’s why PANYNJ asked Bennert and his team to figure out what was going on with the cracking.

A serious look at EWR’s asphalt

Working with 70 field cores recovered from five different runways at Newark and JFK International airports, the CAIT asphalt lab did a thorough forensic analysis of the characteristics and mix components from each runway to determine if comparing the asphalt mixture from runways ‘X’ and ‘Y’ was “apples to apples” or “apples to oranges.” The asphalt binder was a leading suspect in how they were performing.

“The CAIT team set out to understand if the binder selection for P401 is appropriate for the specific climatic and traffic conditions at EWR and JFK, as well as to determine what key asphalt binder and mixture parameters were affecting the fatigue resistance of various runways.

“Airport pavements at Newark were showing top-down cracking, that is, cracks initiating at the surface and traveling 0.5 to 0.75 inches deep. We were interested to see how the asphalt binder properties were changing due to the aging occurring at the surface portion of the cores,” Bennert explained.
The 2.5- to 3-inch thick sample cores were cut into 0.5-inch slices. Then, pavement lab researchers and techs extracted the asphalt binder from the samples and conducted characterization tests on each half-inch slice to evaluate how the asphalt binder is aging over time, furthermore, how the extent of aging changes the deeper it is from the pavement surface. The lab also conducted asphalt mixture fatigue-cracking tests, stressing the pavements to measure when and how much the mixtures failed under “wear and tear.”

Working with PANYNJ project manager Casimir Bognacki (chief of materials), Bennert is PI on the study. PRP lab staff supporting the research are binder specialists Chris Ericson (lead engineer), Rostyslav Shamborovsky (lead technician/graduate student), asphalt mixture specialists Ed Wass Jr. (laboratory manager), Darius Pezeshki (lead engineer), and Ed Haas (lead technician/graduate student).

**No pavement should be old before its time**

CAIT is talking to PANYNJ about doing further development of asphalt binder and mixture specifications that could improve the durability/cracking resistance of runway pavements, something lacking in both FHWA roadway and FAA airfield asphalt mixture specifications. In addition, Bennert proposes formulating performance measures and quality control/testing procedures to ensure final asphalt mixtures produced for the region’s busy airports have the expected fatigue-cracking resistance.

Bennert also shared the results of his analysis to date with the FAA Technical Center in Atlantic City, which expressed interest in a comprehensive study to develop an asphalt binder test that can more accurately and reliably characterize fatigue resistance/durability.

Opposite page: Aerial of Newark Airport. Photo courtesy airport-pictures.net, © DJ.

Below: One of 70 core samples from Newark Airport being analyzed. Photo © Thomas Bennert/Rutgers CAIT.

**Binding dedication**

Rostyslav “Rusty” Shamborovsky, a civil engineering master’s student and CAIT CUTC Student of the Year for 2015, is bound to succeed.

Rusty started working at the CAIT Pavement Resource Program’s (PRP) asphalt laboratory as a technician in his undergraduate junior year and has since risen to the position of lead testing engineer, primarily in asphalt binder. His on-the-job performance and academic achievements over time led CAIT to choose him as the 2015 Council for University Transportation Centers (CUTC) Student of the Year.

When he graduated with his Bachelor of Science degree, he was presented with the Outstanding Engineering Scholar award from the School of Engineering. Professors and coworkers have noted his dedication, work ethic, and qualitative skills in the classroom and on the job. Chris Ericson, Rusty’s supervisor, who heads up binder operations at the PRP asphalt lab, praised his work and commented that Rusty has a trait he doesn’t see in every student worker: “When it comes to reliability and precision, Rusty goes the distance and makes sure testing is done accurately and on time. He also brings to the table something you don’t see a lot in this business: a creative mind.”

Asphalt producers and professional groups also have taken note of Rusty’s skills—and his potential to contribute to the industry. In 2014, he received an award from the North/Central New Jersey section of the American Society of Highway Engineers and soon after that learned he was the recipient of the prestigious David R. Jones Scholarship from the Association of Modified Asphalt Producers. In May 2015 the New Jersey Asphalt Pavement Association also presented him with an award. His most recent recognition came from the Association of Asphalt Paving Technologists (AAPT) in the form of a $2,000 scholarship.

Rusty’s ultimate goal is to make asphalt pavement more cost effective and durable. He was drawn to studying asphalt because it incorporates hands-on work. “So much of civil engineering happens on a computer these days,” Rusty said. “I like getting my hands dirty and the idea of improving something that is going to help both the people who take care of our roads and all of us who drive on them. Computer models and deterioration curves don’t give me quite the same immediate sense of satisfaction.”

Rusty is a member of the student chapter of the American Society of Civil Engineers (ASCE) and participated in the teams for the concrete canoe and steel bridge design competitions as an undergraduate. He also is a member of AAPT.

When he isn’t working in the asphalt lab, Rusty enjoys playing soccer, fishing, riding dirt bikes, and snowboarding.

Above: Rusty Shamborovsky in the binder lab. Photo ©A. Thomas/Rutgers CAIT.
The American Association of State Highway and Transportation Officials (AASHTO) picks four projects annually from each of its four regions to make up the “Sweet Sixteen” collection of high-value research projects that generally fit into a theme of “better—faster—cheaper.”

A CAIT project, Effects of Wide-Base Super Single Tires on Pavements led by Dr. Hao Wang, was chosen as one of the “Sweet Sixteen.” The study sought to answer the question: Are wide-base tires harder on roadways than traditional dual setups consisting of two narrower tires?

Wang, an assistant professor of civil and environmental engineering and CAIT-affiliated researcher, shared the honor with coauthor of the report, Dr. Imad L. Al-Qadi (University of Illinois at Urbana-Champaign), and David L. Huft, the research program manager from the project sponsor, South Dakota Department of Transportation (SDDOT).

Since the early 2000s, tire manufacturers have been marketing wide-base single tires to the trucking industry as replacements for traditional dual tires on tractor trailers. Claims were that the “super single” tires saved fuel, lowered emissions, and provided better stability control.

State DOTs are concerned about how this relatively new product could impact their roads, especially regarding pavement damage, added maintenance, and rehabilitation frequency—all affecting operational costs.

With the oil and gas boom in the Plains states increasing heavy truck traffic to the region, and legislation pending in South Dakota that would allow wide-base tires, SDDOT was especially interested in quantifying the effects on pavements caused by these super singles versus standard dual tires.

Up until this study, South Dakota law set limits for non-steering axles at 500 pounds per inch of tire width. Because the load-to-inch ratio is higher for super singles, truck operators driving through that state would have to reduce payload, use conventional dual tires, or adjust their routes to avoid South Dakota roads altogether. SDDOT wanted to assess the potential increase in pavement damage if they allowed the same loads for wide-base tires as tradition dual tires. According to the report summary:

This study investigated the impact of wide-base tires on two typical flexible pavement structures—full-depth and thin asphalt pavements—through accelerated testing and advanced finite element modeling.

Three tire configurations (dual, first-generation 425 wide-base, and the new generation 455 wide-base) and various road sections were considered. The advanced modeling simulated realistic tire-pavement interaction and considered appropriate material properties for each pavement layer. It was evident from this study that, of the three possibilities, the wide-base 425 tires caused the greatest pavement damage. The wide-base 455 tire caused greater bottom-up fatigue cracking and increased potential for subgrade rutting on most tested sections. However, the impact of wide-base tires on fatigue cracking and subgrade rutting potential became less significant with a stronger pavement structure. The finite element modeling results indicated that, compared with the dual-tire assembly, the wide-base 455 tire resulted in similar or less primary rutting potential in thin asphalt pavements and less near-surface cracking potential in thick asphalt pavements.

In short, the study found thick asphalt pavements with substantial bases could withstand the super single tires, whereas roads with thin pavements or gravel fared poorly. Based on this outcome, SDDOT accepted legislation allowing their use on main freight routes, but excluding them from state routes and essentially all local roads.

The study also confirmed that because there is less rolling resistance at the tire-to-pavement interface, wide-base tire technology does reduce vehicle fuel consumption and greenhouse gas (GHG) emissions—benefits that can lessen the environmental impact of the trucking industry that our country heavily relies on.

Yangmin Ding received the first place award in a Student Poster Competition organized by the International Association for Chinese Infrastructure Professionals (IACIP) and held in Washington, DC. His winning poster, “Prediction of Tire-Pavement Noise under Different Tire Configurations Using Coupled FEM and BEM Analysis” also was presented at the Transportation Research Board Annual Meeting in January 2015.

Ding also received a travel award from Graduate School–New Brunswick to present his research work at the Annual Conference of Tire Science and Technology, which was held in September 2015.

Ding is currently a second year doctoral student in civil and environmental engineering. His adviser is Dr. Hao Wang.
CAIT robot team lands Best Poster award at NJDOT research showcase

At NJDOT’s Annual Research Showcase, universities partnering with the agency have the opportunity to display informative posters that summarize their research activities. One poster is chosen each year for the Best Poster award.

This year, the honor went to the CAIT team in charge of continuing development on the RABIT™ bridge deck assessment robot, which simultaneously deploys multiple NDE technologies and combines the data from each into a comprehensive picture of the bridge’s health.

Team member Jinyoung Kim displayed the poster at the event and accepted the award on behalf of the rest of the RABIT team: leader Dr. Nenad Gucunski, Dr. Basily Basily, Dr. Ali Maher, Kien Dinh, Trung Duong, and Shane Mott. CAIT communications and art director Allison Thomas designed the poster.

Young faculty on track for a brilliant career

Civil engineering assistant professor Dr. Xiang Liu received the biennial Young Member scholarship award from the Committee on Railroad Operational Safety (AR070) based on his first paper as a Rutgers faculty member. He was invited to present his paper and give an overview of rail research activities at Rutgers at the Annual Transportation Research Board meeting held each January in Washington, DC. CAIT and the Department of Civil and Environmental Engineering supported the research that Liu submitted.

The Committee on Railroad Operational Safety invites researchers who are 35 years of age or younger to submit papers. Judging criteria include how well the paper addresses research needs statements, its applicability to the railroad industry, quality of analysis, thoroughness, originality/creativity, and clarity of thought and expression. The winner receives reimbursement for his or her TRB conference registration and travel expenses.

Liu’s paper presents a theoretical framework and practical tool for analyzing the safety trend of freight railroads from 2000 to 2012 in the United States. The statistical analysis quantifies the magnitude of train safety performance improvement in the last 13 years, and projects future train derailment rates by major accident causes. This research aims to provide the Federal Railroad Administration and the railroad industry with an analytical tool to monitor, analyze, and predict annual train accident rates, thereby developing better-informed safety policies and practices.

Dr. Liu’s research interests focus on railroad safety and risk management. His current work addresses crude oil by rail risk analysis, track failure prediction, safety management of positive train control, and railroad data analytics. He also teaches rail engineering and risk analysis courses at Rutgers.

The Committee on Railroad Operational Safety is concerned with research on human performance and human factors issues related to railroad operations. The committee defines, encourages, and disseminates research results that will enhance the safety, performance, and efficiency of railroads and the comfort of those who are involved in and/or use railroad and rail-related transportation.

Legislators invite CAIT to help promote infrastructure funding

Senator Robert Menendez (D-NJ) and Congressman Frank Pallone Jr. (D-NJ-06) asked CAIT to join them for a press event with transportation advocates and labor leaders on May 15, 2015. The aim was to compel Congress to approve a long-term transportation bill. At the time, funding for highway, transit, and safety programs would expire at the end of the May, and the federal Highway Trust Fund (HTF) faced insolvency by summer.

To emphasize their message, they chose one of New Jersey’s 2,300 structurally deficient bridges as the location for the event: the Route 35 bridge over CR624/Route 440 in Perth Amboy, which was built in 1960 and carries 22,000 cars daily. NJDOT has it scheduled for full replacement in FY2016.

“The sooner Republicans join Democrats to take responsibility for repairing our country’s transportation system, the less it will cost to maintain in the future,” said Pallone. “The need for renewal of the Highway Trust Fund and … robust investment in infrastructure is twofold—[as] a boost to the economy and job creation [and for] the long-term safety and health of our transportation system.”

“The ability to move people and goods … is critical to our economy and our quality of life,” said Menendez. “We can’t keep pretending the problem is going to resolve itself. … We can’t afford not to fix it.”

Happily, after more than 10 years of extensions and continuances, and just hours before the previous legislation extension expired, the House and Senate passed a five-year bill: the $305 billion Fixing America’s Surface Transportation (FAST) Act.

Guests attending the press conference included Joseph McNamara of the New Jersey Laborers Union; Erin Rice of the Operating Engineers Local 825; Daniel Ortega of the Engineers Labor-Employer Cooperative; Janna Chernetz of the Tri-State Transportation Campaign; Dr. Patrick Szary of Rutgers Center for Advanced Infrastructure and Transportation (CAIT); Andrés Roda of CAIT’s Bridge Evaluation and Accelerated Structural Testing Lab (BEAST); and Tracy E. Noble and Cathleen Lewis of AAA Mid-Atlantic.

Menendez, Pallone, and Assemblyman John Wisniewski (D) have been long-standing staunch advocates for boosting infrastructure investment.

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:

- #road 8,124,145
- #railroad 596,185
- #bridge 6,911,088
- #transportation 320,800
- #highway 2,003,936
- #powerlines 233,350
- #tunnel 1,018,897
- #asphalt 139,336
- #concrete 977,021
- #infrastructure 61,394

Instagram user named below each photo holds copyright to their corresponding image.
**ASCE Young Engineer Award**

Andy Kaplan, E.I.T., manager of CAIT’s Transportation Safety Resource Center, was named Young Civil Engineer of the Year. Kaplan accepted the award at the ASCE New Jersey Section 41st Annual Awards Dinner on May 8, 2015. The event celebrates the accomplishments of New Jersey engineers and excellence in the profession. Award candidates are nominated by peers from across the state.

**Your source for safety training**

As a member of the FHWA-sponsored Rural Road Safety Center at Montana State University and the Northeast Transportation Training Center at the University of Vermont, NJ LTAP wants you to know about these safety training resources. You can find listings for webinars and other trainings, plus a wealth of information to help your state be a safe state. Visit [ruralsafetycenter.org/training-education](http://ruralsafetycenter.org/training-education) and [netwc.net](http://netwc.net) for more info.

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

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

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