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Impact Statement

In New Jersey and the Northeast region, transportation funding has taken center stage in recent months. This March, NJ Governor Phil Murphy signed legislation renewing NJ's Transportation Trust Fund (TTF) for five more years. The TTF, comprised of critical projects identified by NJ Transit and the NJDOT annually and approved by the State legislature, plays a major role in keeping NJ's 9.3 million people moving. The reauthorization will provide billions of dollars in appropriations for the State's Annual Transportation Capital Program from FY 2025 through FY 2029, supporting NJ counties, municipalities, communities, NJDOT, and NJ Transit.

Amid a period of persistent inflation and economic uncertainties, this transportation funding was a pressing challenge for lawmakers to address. For example, in April NJ Transit for the first time in nearly a decade approved a 15% fare increase for bus and train riders. The agency cited high costs and an estimated 30% rise in inflation since 2015 as a major reason for the fare hike. Post-pandemic financial challenges also continue to impact regional rail agencies as federal COVID-19 aid dries up but ridership remains below pre-pandemic levels.

These hardships are felt throughout the Northeast and beyond, and at times have impacted CAIT and our regional stakeholders—requiring staggering of resources, delaying project delivery due to staffing shortages at agency partners, and shrinking the pool of graduate students available to conduct research. At the same time, secured funding represents a new opportunity for reinvestment in regional transportation and exploring innovative technologies that can make systems more cost-efficient, safer, sustainable, resilient, and equitable.

CAIT has continued its approach of leveraging its extensive research network in the Northeast to conduct meaningful and practical research. Multi-year projects and partnerships have enabled the Center to "weather the storm" and continue developing and deploying innovative technology in the hands of transportation professionals today. Select project examples and accomplishments are highlighted below.

- **Deploying AI-Powered Safety Solutions:** Every 3 hours a person is hit by a train in the US, and during the past decade 96% of all rail-related fatalities have occurred at track grade crossings due to trespassing, suicide, and other accidents. CAIT has been working closely with NJ Transit and NJDOT to equip 10+ grade crossings throughout the State with cameras and AI-powered technologies to monitor trespassing behavior and design safety countermeasures. CAIT leveraged UTC research to develop the initial trespassing-detection system incorporating artificial intelligence, which can sort through video footage and accurately recognize and track objects. CAIT recently won a USDOT SMART grant to further deploy this innovative safety approach.

    CAIT and the Rutgers Rail Lab also hosted the FRA's "Grade Crossing Safety & Railroad Trespass Prevention Workshop" in February. The event brought hundreds of transit professionals together to discuss the latest technologies and approaches for mitigating, reducing, and eliminating highway-rail grade crossing and trespasser incidents.

- **Innovative Approaches to Infrastructure Monitoring:** A recently completed UTC project deployed AI-aided camera systems on infrastructure around the Luis Muñoz Marín International Airport in Puerto Rico to monitor weather and flood events and collect critical resilience data. Cameras were installed to monitor water depth in the coastal area in front of the airport. AI-based data processing algorithms were implemented to assess and map flooding depth and infrastructure damage. The data collected can enhance infrastructure development and maintenance capacity in Puerto Rico, and help coastal airport managers plan for flooding and climate change impacts.
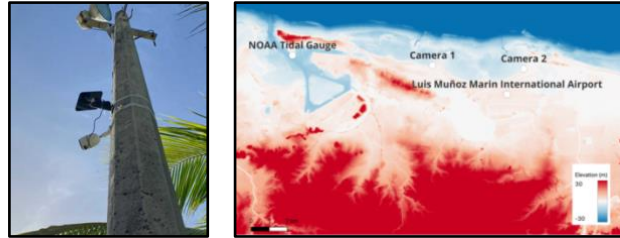
  Another recent success in the area of infrastructure inspection and monitoring, CAIT researcher and Rutgers faculty member Dr. Hao Wang was awarded a $1M Pipeline and Hazardous Materials Safety Administration (USDOT-PHMSA) grant to enhance pipeline inspection and maintenance through advanced modeling, data analytics, and remote sensing technologies.

- **Using Smart Mobility Data to Enhance Transportation Equity:** Multiple UTC seed projects were critical to launching CAIT's DataCity Smart Mobility Testing Ground, which has grown into a major area of interest for local project partners Middlesex County and NJDOT. Since DataCity's launch in May 2021, the instrumented corridor has expanded to 3.1 miles and the County has invested $8M+ in the initiative. This includes the establishment of a Traffic Operations and DataCity Control Center home to a 1.5 PB storage facility, state-of-the-art NVIDIA GPU powered analytic center, and a large-scale curved videowall system.

  This investment has the potential to translate into local safety and mobility improvements for the City of New Brunswick, a historically underserved community. According to 2020 Census Data, New Brunswick has a 32% poverty rate and just 24% of residents over the age of 25 have a college degree. This area is also home to a high number of school-age and young-adult pedestrians. Considering this, Rutgers researchers are now using mobility information from DataCity—including analysis of thousands of crashes and near-miss incidents—to develop and recommend safety countermeasures. An active UTC project, "Resilience and Mobility Accessibility in Underserved Communities," is supporting this aspect of DataCity by fostering community partnerships to understand needs, developing apps and safety tools that are accessible to residents, and working with stakeholders to implement data-driven safety measures at high-risk locations.

ACCOMPLISHMENTS (What was done? What was learned?)
What are the major goals and objectives of the program?
The CAIT Region 2 UTC Consortium's research vision aligns with ongoing national dialogue on the state of the U.S. transportation infrastructure, and the emerging consensus on the need for investment to fill condition gaps, improve/expand existing systems, and build for the future.

The Consortium's **primary research focus** will be on "Improving the Durability and Extending the Life of Transportation Infrastructure," with additional elements of "Preserving the Existing Transportation System," such as resilience.

Using Region 2 as a complex infrastructure laboratory, the Consortium will contribute to: 1) extending the life of the region's legacy systems, 2) building future systems with consideration to changes in living patterns and where people and products will move to and from, and 3) the use of technologies and better design approaches to maximize the use of both old and new transportation infrastructure assets.

The Consortium will structure its **education and workforce development activities** around a "cradle to grave" approach, developing programs that attract more people to the transportation industry, fostering skills to sustain them within the industry, and providing the workforce with professional development.

Gaining and sharing knowledge is the critical first step toward developing a transportation system that improves the durability and extends the life of transportation infrastructure. To this end, the Consortium will conduct **technology transfer** of research through implementation projects, knowledge transfer activities, and exploration of patents.

What was accomplished under these goals?

Fostering Diversity, Equity, & Inclusion
As the State University of New Jersey, Rutgers is committed to nurturing and enhancing opportunities for all students at the university and residents of NJ. In March 2022, Rutgers published its inaugural **"University Diversity Strategic Plan,"** laying the foundation and identifying action steps toward achieving comprehensive diversity, equity, and inclusion.

Rutgers identified five guiding pillars in the Plan, which CAIT aligns to and follows across its research, education, and training portfolio. The pillars are **1)** Developing a Diverse Community, **2)** Promoting Inclusive Scholarship, **3)** Defining Substantive Community Engagement, **4)** Building Capacity for Inclusive Climates, and **5)** Developing the Infrastructure to Drive Change.

In the spirit of this initiative, CAIT has launched multiple projects in recent years designed to promote diversity and equity in the transportation field. Select examples leveraging UTC research are highlighted below:

- **Rutgers Youth Success Program:** Strategic workforce development program supporting justice-impacted youth from the City of Camden NJ, a historically underserved community, to help them find apprenticeships and pathways to sustainable careers in transportation. This work leverages UTC projects such as the ["Camden Career Pathways Initiative"](#) that is building databases of local employers and opportunities for and barriers to employing justice-impacted youth. The RYSP has supported 300+ youth since 2021 expanding throughout South Jersey, with an 82% attainment rate for apprenticeship/employment/return to education among participants.

- **Developing Indicators for Comprehensive Evaluation of Equity in Transportation System:** A [UTC project](#) engaging the Camden Community Partnership developing an evaluation technique to best incorporate equity principles—such as accessible first-and-last mile mobility options—in transit and community planning, construction processes, and transportation decision-making. This study stems from research with UTC partners at Rowan University who surveyed Camden City residents as part of an outreach campaign to understand current mobility gaps and opportunities for improvements.

- **International Women's Day Seminar:** An annual seminar organized by CAIT celebrating International Women's Day and recognizing women leaders in transportation. Starting in [March 2021](#), CAIT has now hosted three seminars showcasing the research and accomplishments of women faculty across its UTC consortium, from evolving freight planning to meet modern supply chain needs to building tunnels more resilient to fire. Speakers from local stakeholders such as the North Jersey Transportation Planning Authority have also been engaged in previous seminars.

These initiatives demonstrate organizational commitments at CAIT to foster diversity and inclusion, in alignment with the guiding pillars established in the Rutgers Plan. The UTC program has accelerated the growth and development of these initiatives through strategic support projects and enabling close collaboration with partner schools in Region 2. CAIT consortium members are making similar commitments, such as Rowan University launching its Division of Diversity, Equity, and Inclusion in 2019 and NJIT welcoming its most diverse undergraduate class in 2023 with underrepresented minority students making up 50% of first-year enrollment.

Research

No new projects were approved by the peer-review panel during this cycle.

Ongoing Projects:

CAIT-UTC-REG25	Investigation of Balanced Mixture Design for New York State Asphalt Mixtures	RU
CAIT-UTC-REG40	Zero Speed Profiler Assessment for Pavement Smoothness and Continuous Pavement Texture Measurements	RU
CAIT-UTC-REG56	Interactive decision support system for tunneling planning and construction: Hudson Tunnel case study	NJIT/Stevens
CAIT-UTC-REG59	Durability of Low Carbon Concrete Mixtures	NJIT
CAIT-UTC-REG63	State-of-the-art technologies for structural health monitoring of tunnels: an overview	PU
CAIT-UTC-REG64	NJ Transit Northern Bus Garage Planning and Community Impact Evaluation	RU
CAIT-UTC-REG66	Comparison Analysis of Charging System Designs for Battery Electric Bus	RU
CAIT-UTC-REG69	Camden Career Pathways Initiative	RU
CAIT-UTC-REG70	Developing Indicators for Comprehensive Evaluation of Equity in Transportation System	Rowan
CAIT-UTC-REG71	Bio-mediated method for improving the erosion resistance of coastal embankment	Rowan
CAIT-UTC-REG72	Planning Project for Initiating A Large-scale 3D Printing Facility	RU/PU
CAIT-UTC-REG73	Asphalt Viability in Recycled Asphalt Pavement (RAP) Using the Gyratory Compactor	RU
CAIT-UTC-REG75	Mitigating Cracks in Concrete Members for Durable Bridge Construction	UB
CAIT-UTC-REG76	Advanced Testing and Modeling of Dredged Sediments for Beneficial Use	RU
CAIT-UTC-REG77	Identification Potential of Microplastics from Recycled Plastic Modified Asphalt Mixtures	RU
CAIT-UTC-REG78	Evaluation of the Effects of Superstructure Characteristics on the Performance of Bridge Decks under Traffic Loads	RU
CAIT-UTC-REG79	Resilience and Mobility Accessibility in Underserved Communities	RU
CAIT-UTC-REG80	Full-scale "Living Pavement Testbed" for Testing and Evaluation of Sustainable Pavement	RU
CAIT-UTC-REG81	A Hydrologic Modeling Framework for Assessing Future Riverine Flood Risk of Critical Transportation Infrastructure	RU
CAIT-UTC-REG82	Risk and Resiliency Analysis of Infrastructure by Improving RAMCAP Framework	Rowan
CAIT-UTC-REG83	Assessment of Waterfront Asset Resiliency	RU
CAIT-UTC-REG84	Test Bed Mesocosms for Improved Stabilized Sediment Laboratory Specimen Preparation and Field QA/QC	RU
CAIT-UTC-REG85	Identifying the Effect of Bridge Deterioration on Load Distribution	RU
CAIT-UTC-REG86	Development of A Digital Testbed for Connected Transit Technologies	RU

Completed Projects:

CAIT-UTC-REG1	Augmented Reality (AR) in Life-Cycle Management of Transportation Infrastructure Projects	RU
CAIT-UTC-REG2A	Sustainability and Resiliency of Concrete Rapid Repairs Utilizing Advanced Cementitious Materials – Freeze/Thaw Loads	NJIT
CAIT-UTC-REG2B	Sustainable, Rapid Repair Utilizing Advanced Cementitious Materials	SUNY Buffalo
CAIT-UTC-REG3	Large-Amplitude Forced Vibration Testing for St-Id of Bridges and Foundation Reuse Assessment	RU
CAIT-UTC-REG4	Rail Track Asset Management and Risk Management	RU
CAIT-UTC-REG5	Implementation and Development of UAS Practical Training for Inspection and Monitoring Activities	ACCC
CAIT-UTC-REG6	Airfield Pavement Management Framework using a Multi-Objective Decision-Making Process	RU

| CAIT-UTC-REG7	MEMS Sensor Development for In-Situ Quantification of Toxic Metals in Sediment	RU
CAIT-UTC-REG8	Prioritizing Infrastructure Resilience throughout the Capital Planning Process	RU
CAIT-UTC-REG9	Delivering maintenance and repair actions via automated/robotic systems	RU
CAIT-UTC-REG10	Policies, Planning, and Pilot Testing on Infrastructure Readiness for Electrical, Connected, Automated, and Ridesharing Vehicles	RU/Columbia
CAIT-UTC-REG11	Pavement Design for Local Roads and Streets	Cornell
CAIT-UTC-REG12	Laboratory Performance Evaluation of Pavement Preservation Alternatives	Rowan
CAIT-UTC-REG13	Virtual Tour (VT), Informational Modeling (IM), and Augmented Reality (AR) for Visual Inspections (VI) and Structural Health Monitoring (SHM)	PU
CAIT-UTC-REG14	Performance-Based Engineering of Transportation Infrastructure Considering Multiple Hazards	SUNY Buffalo
CAIT-UTC-REG15	Flood Vulnerability Assessment and Data Visualization for Lifeline Transportation Network	Rowan
CAIT-UTC-REG16	Fire In Tunnel Collaborative Project	PU/SUNY-Buffalo/NJIT
CAIT-UTC-REG17	Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part I - Analysis of failure of transportation signs due to Hurricane Maria	PUPR
CAIT-UTC-REG18	Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part II – Analysis of pedestrian bridges failures due to Hurricane Maria	PUPR
CAIT-UTC-REG19	Improving Transportation Infrastructure Resilience against Hurricanes, other Natural Disasters, and Weathering: Part III - Analysis of motor vehicle bridges failures due to Hurricane Maria	PUPR
CAIT-UTC-REG20	Infrastructure Cybersecurity and Emergency Preparedness Academic and Non-academic Credential Development	SUNY Farmingdale
CAIT-UTC-REG21	Autonomous Vehicles: Capturing In-Vehicle Experience & Focus Group Follow-up with Persons with Autism and Other Disabilities at the 2019 Princeton University SmartDrivingCar Summit	RU
CAIT-UTC-REG22	Simulation of Degradation and Failure of Suspension Bridge Main Cables due to Natural and Anthropogenic Hazards	Columbia
CAIT-UTC-REG23	The Development of a Smart Intersection Mobility Testbed (SIMT)	RU
CAIT-UTC-REG24	Application of Advanced Analytic and Risk Techniques to Railroad Operations Safety and Management	RU
CAIT-UTC-REG26	Passenger Flow Modeling on Platform Tracks in Transit Stations	RU
CAIT-UTC-REG27	Designing Concrete Mixtures with RCA	NJIT
CAIT-UTC-REG28	Cost-effective Bridge Decks for Improved Durability and Extended Service Life	RU
CAIT-UTC-REG29	Seismic Vulnerability Assessment of Deteriorated Bridges	SUNY Buffalo
CAIT-UTC-REG30	Durable and Electrified Pavement for Dynamic Wireless Charging of Electric Vehicles	RU
CAIT-UTC-REG31	Evaluating the Safety and Mobility Impacts of American Dream Complex: Phase I (Feasibility Study, and Data Acquisition)	Rowan
CAIT-UTC-REG32	Rotorcraft Landing Sites – An AI-Based Identification System	Rowan
CAIT-UTC-REG33	Real-Time Prediction of Storm Surge and Wave Loading on Coastal Bridges	SUNY Buffalo
CAIT-UTC-REG34	Assessing and Mitigating Transportation Infrastructure Vulnerability to Coastal Storm Events with the Convergence of Advanced Spatial Analysis, Infrastructure Modeling, and Storm Surge Simulations	RU
CAIT-UTC-REG35	NJDOT Flood Risk Visualization Tool	RU
CAIT-UTC-REG36	Improving the Long-Term Performance of Bridge Decks through Full-Scale Accelerated Testing	RU
CAIT-UTC-REG37	Impact of Recycled Plastic on Asphalt Binder and Mixture Performance	RU

CAIT-UTC-REG38	Risk and Resilience Analysis Tool for Infrastructure Asset Management	RU
CAIT-UTC-REG39	FDR Stabilizer Selection Using Simple Soil Tests	Cornell
CAIT-UTC-REG41	Affordable On-Demand Testing of Water Contamination Using a Portable Nanoelectronic Lead Detector	RU
CAIT-UTC-REG42	Enhanced Maritime Asset Management System (MAMS)	RU
CAIT-UTC-REG43	Artificial Intelligence-Aided Rail Transit Infrastructure Data Mining	RU
CAIT-UTC-REG44	Assessment of Solidification / Stabilization as a Remedial Strategy for PFAS Contaminated Transportation Sites	RU
CAIT-UTC-REG45	The Development of the Digital Twin Platform for Smart Mobility Systems with High-Resolution 3D Data	RU
CAIT-UTC-REG46	Driving behavioral learning leveraging sensing information from Innovation Hub	Columbia
CAIT-UTC-REG47	Remote Sensing System Enhancement for Digital Twinning of the Built Infrastructure to Support Critical Infrastructure Protection Research	RU
CAIT-UTC-REG48	Linking Physics-Based Deterioration Model to Field-Based Condition Assessments for Improving Asset Management	SUNY Buffalo
CAIT-UTC-REG49	Post-fire Damage Assessment of Concrete Tunnel Liners	SUNY Buffalo
CAIT-UTC-REG50	Post-disaster Damage Assessment of Bridge Systems	SUNY Buffalo
CAIT-UTC-REG51	Real-Time Decision Support System for Transportation Infrastructure Management under a Hurricane Event	SUNY Buffalo
CAIT-UTC-REG52	Bridge Deck Surface Profile Evaluation for Rapid Screening and Deterioration Monitoring	Rowan
CAIT-UTC-REG53	A Real-Time Proactive Intersection Safety Monitoring System Based on Video Data	Rowan
CAIT-UTC-REG54	Rotorcraft Landing Sites Identification – Scaling and Generalization of the AI Model	Rowan
CAIT-UTC-REG55	JFK Cargo View: A system to speed Truck Traffic Flow at JFK Airport	RU/ SUNY Farmingdale
CAIT-UTC-REG57	Comparative analysis of rapid chloride penetration testing for novel reinforced concrete systems	NJIT
CAIT-UTC-REG58	Supplemental Study of Filter Technology Efficacy for Transit Vehicles to Combat the Spread of COVID-19 and Other Respiratory Infections	RU
CAIT-UTC-REG60	Low-Carbon Concrete Pilot Program	PU
CAIT-UTC-REG61	QAD (Quality Assurance Division) Inspection Reporting and State of Good Repair (SGR) Planning	RU
CAIT-UTC-REG62	AI-supported Monitoring and Resiliency Analysis for the Coastal Area of the Luis Muñoz Marín International Airport in Puerto Rico	RU/PUPR
CAIT-UTC-REG65	Development of a Geometric Extraction Tool as Part of a Pilot Digital Twin Framework for Open-Deck Rail Bridges	RU
CAIT-UTC-REG67	Enhancing the resilience of coastal box girder bridges through geometric modifications	PU
CAIT-UTC-REG68	A Machine Learning Decision-Support System for Selecting Optimal Innovative Project Delivery Methods for Bundled Transportation Projects	NJIT
CAIT-UTC-REG74	Rapid Damage Assessment in Infrastructure Systems using Vibration Measurements within a Machine Learning Framework	Columbia

Highlights
Completed Projects (select highlights from recently completed projects)

Passenger Flow Modeling on Platform Tracks in Transit Stations (CAIT-UTC-REG26, Project Manager: Dr. Xiang Liu)

Accomplishments: Development of an AI-based trespass monitoring system that rapidly detects and analyzes pedestrian and vehicle motion at rail-grade crossings. CAIT recently won a USDOT SMART grant that will further deploy this innovative rail safety technology.
ROI: Every three hours someone is struck by a train in the US. This tool allows transit agencies to measure what they could not previously see, understand trespassing behavior at grade crossings, and design data-driven safety countermeasures.
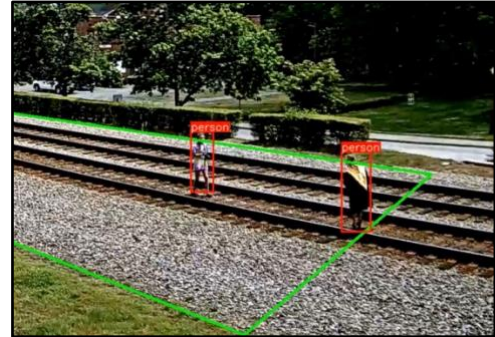
Low-Carbon Concrete Pilot Program (CAIT-UTC-REG60, Project Manager: Dr. Reza Moini)

Accomplishments: CAIT and consortium partners NJIT and Princeton identified 18 concrete mix designs that can reduce GHG emissions by up to 37% for the Port Authority of NY & NJ.
ROI: Port Authority has implemented this research and updated sustainability standards into its Low Carbon Concrete Program. Two reports have been published under the agency's Clean Construction Program. Port Authority continues to work with the CAIT UTC consortium in support of its agency-wide GHG reduction target of 80% by 2050.

AI-supported Monitoring and Resiliency Analysis for the Coastal Area of the Luis Muñoz Marín International Airport in Puerto Rico (CAIT-UTC-REG62, Project Manager: Dr. Roger Wang)

Accomplishments: Deployed AI-aided camera systems on infrastructure around the Luis Muñoz Marín International Airport in Puerto Rico to monitor weather and flood events and collect critical resilience data. This data has been shared with aviation infrastructure stakeholders.
ROI: The data collected can enhance infrastructure development and maintenance capacity in Puerto Rico, and help coastal airport managers plan for flooding and climate change impacts. The monitoring system can also be enhanced based on feedback and deployed to other transportation infrastructure.

Development of a Geometric Extraction Tool as Part of a Pilot Digital Twin Framework for Open-Deck Rail Bridges (CAIT-UTC-REG65, Project Manager: Dr. Amirali Najafi)

Accomplishments: This project established an alternative approach to replace open-deck railway bridge timbers using UAV-based inspections and artificial intelligence.
ROI: An algorithm was developed for rapidly identifying the geometry of individual railway bridge components. Using 3D scans and automation reduces the maintenance costs and accuracy challenges for open-deck bridge maintenance procedures.

Rapid Damage Assessment in Infrastructure Systems using Vibration Measurements within a Machine Learning Framework (CAIT-UTC-REG74, Project Manager: Dr. Raimondo Betti)

Accomplishments: Developed a machine learning algorithm for rapid assessment of structural damage in bridges that is capable of processing recorded measurements of the structural response in almost "real" time and providing a rapid health assessment. This algorithm was tested on the bridge deterioration dataset from CAIT's BEAST lab.

ROI: This algorithm can provide a nearly real-time assessment of structural health, which could be a powerful tool for bridge owners to deploy. For example, if a bridge is exposed to extreme weather, fire event, or natural disaster, a tool such as this could allow an engineer to quickly determine if traffic needs to be stopped or if the structure remains healthy.

Ongoing Projects (select highlights from active projects)

Investigation of Balanced Mixture Design for New York State Asphalt Mixtures (CAIT-UTC-REG25, Project Manager: Dr. Thomas Bennert)

Outputs: A non-proprietary final report covering the work performed under this research study.
Outcomes: Training and specifications will be developed and implemented within NY State.
Impacts: Study results will help NYSDOT improve mixture design and testing programs.

Cost-effective Bridge Decks for Improved Durability and Extended Service Life (CAIT-UTC-REG28, Project Manager: Dr. Sougata Roy)

Outputs: This project is developing cost-effective standard open rib SOBD to promote increased implementation of SOBD for short and medium span highway bridges.
Outcomes: Potential design specifications to be incorporated into AASHTO Specifications.
Impacts: The research findings have the potential to be adopted by steel bridge fabricators for streamlining production, economizing fabrication, and competitive advantage.

Interactive decision support system for tunneling planning and construction: Hudson Tunnel case study (CAIT-UTC-REG56, Project Manager: Dr. Matthew Bandelt)

Outputs: This project aims to increase safety and minimize the risks of building major underground infrastructure systems by enhancing existing methods for risk assessment.
Outcomes: A framework for global large-scale tunneling projects able to determine hazards.
Impacts: This interactive decision support system will have the potential to be used in the design and construction of different tunnels in the US by local, regional, and federal agencies.

NJ TRANSIT Northern Bus Garage Planning and Community Impact Evaluation (CAIT-UTC-REG64, Project Manager: Dr. Peter Jin)

Outputs: This project will help NJ TRANSIT create a complete roster of the 500-bus capacity Northern Bus Garage and determine critical facility metrics.
Outcomes: Several modules for bus dispatching, including data archiving, processing and visualization, will be developed and integrated with the NJ TRANSIT bus scheduling system.
Impacts: Data generated will provide insights into the impact of the new garage, specifically on improvements to NJ TRANSIT bus operations within the service areas.

Comparison Analysis of Charging System Designs for Battery Electric Bus (CAIT-UTC-REG66, Project Manager: Dr. Hao Wang)

Outputs: A robust charging system for battery electric buses considering economic and environmental impacts will be developed and analyzed through this research project.
Outcomes: This project is developing a methodology to help NJ TRANSIT select the best charging system design with less life-cycle cost and carbon footprint.
Impacts: The results will help NJ TRANSIT develop its deployment strategy for charging infrastructure and refine its garage modification plans to support zero-emission bus systems.

Developing Indicators for Comprehensive Evaluation of Equity in Transportation System (CAIT-UTC-REG70, Project Manager: Dr. Mohammad Jalayer)

Outputs: An evaluation technique to assess and maintain equity principles in transportation planning and construction processes, and further incorporate them into decision-making.
Outcomes: Indicators for transportation agencies to better consider equity in projects.
Impacts: These guidelines will help industry adopt more equitable transportation practices.

Planning Project for Initiating A Large-scale 3D Printing Facility (CAIT-UTC-REG72, Project Manager: Dr. Meiyin Liu)

Outputs: This project will identify the roadmap towards a successful and sustainable large-scale 3D printing facility to be used in construction of durable components of infrastructure.
Outcomes: a comprehensive review of 3D printing for transportation and/or general civil infrastructures, which can work as a fundamental knowledge base for decision-making process.
Impacts: This research has the potential to advance the manufacturing process for improvements towards sustainable and resilient civil infrastructure using 3D.

Asphalt Viability in Recycled Asphalt Pavement (RAP) Using the Gyratory Compactor (CAIT-UTC-REG73, Project Manager: Dr. Thomas Bennert)

Outputs: This project will evaluate the viability of asphalt binder in RAP materials using a simplified procedure with the gyratory compactor.

Outcomes: The intended outcome of the project is to provide a quick and accurate means of evaluating RAP that can be utilized back into new asphalt materials.
Impacts: The researchers will generate a proposed parameter and recommended thresholds that would allow asphalt mixture suppliers to determine maximum RAP contents based on existing asphalt binder grades, softer binder grades, and recycling agents.

Advanced Testing and Modeling of Dredged Sediments for Beneficial Use (CAIT-UTC-REG76, Project Manager: Dr. Tyler Oathes)

Outputs: This project will generate modeling approaches for the beneficial use of raw and stabilized sediments in engineering applications.

Outcomes: Guidance and methodologies will be developed for modeling sediments in engineering applications using approaches tailored to different beneficial uses.

Impacts: There are a wide range of potential beneficial uses that require varying levels of engineering performance and modeling breadth, which this project will support.

Identification Potential of Microplastics from Recycled Plastic Modified Asphalt Mixtures (CAIT-UTC-REG77, Project Manager: Dr. Thomas Bennert)

Outputs: This project will evaluate the potential release and detection of micro-plastics from hot mix asphalt modified with recycled plastic modifiers.

Outcomes: Training products, such as a webinar and/or training classes, will be developed and distributed to industry members investigating the use of plastic waste in roadway paving.

Impacts: This research will help the asphalt industry identify when potential release of microplastics from asphalt mixtures can occur. As asphalt mixes using plastic waste are investigated, it is important to ensure their safety and environmental sustainability.

Evaluation of the Effects of Superstructure Characteristics on the Performance of Bridge Decks under Traffic Loads (CAIT-UTC-REG78, Project Manager: Dr. Sharef Farrag)

Outputs: This project will assess stresses exhibited by the deck under traffic loads.

Outcomes: Researchers will conduct a parametric study evaluating the extent to which varying bridge superstructure and deck aspects contribute to the deterioration of the bridge deck.

Impacts: This research will reveal which type of bridges are more prone to mechanical/vibration damage as opposed to those that exhibit electrochemical deterioration.

Resilience and Mobility Accessibility in Underserved Communities (CAIT-UTC-REG79, Project Manager: Dr. Peter Jin)

Outputs: This project will identify the existing traffic, safety, and environmental problems caused by pass-through traffic and natural calamities in New Brunswick, NJ.

Outcomes: New partnerships with local agencies and communities will be formed to better understand their mobility, safety, and transportation needs.

Impacts: This research will boost the local transportation system's resilience and efficiency, ensuring its longevity and that it is serving the community in an equitable and effective way.

Full-scale "Living Pavement Testbed" for Testing and Evaluation of Sustainable Pavement (CAIT-UTC-REG80, Project Manager: Dr. Thomas Bennert)

Outputs: This project will study the impacts of both common and innovative construction techniques on pavement performance and durability in a living environment on the Rutgers University Busch Campus.

Outcomes: Industry will better understand the impacts of common and innovative construction methods such as milling, "Cold in Place Recycling," and High Friction Surface Treatments.

Impacts: This research can develop best practices for innovative construction techniques that help to address climate and sustainability challenges. It also opens the door for advanced, hands-on training at the living lab of DOT staff and other pavement professionals.

A hydrologic modeling framework for assessing future riverine flood risk of critical transportation infrastructure (CAIT-UTC-REG81, Project Manager: Dr. Efthymios Nikolopoulos)

Outputs: This research will develop a high-resolution distributed hydrologic model for NJ.
Outcomes: The model will provide space-time information of streamflow during flood events and will be calibrated/validated against USGS streamflow stations.
Impacts: Researchers will use this model to identify "hot spots" in the region for future riverine flood risk, and will engage local stakeholders to disseminate this information.

Risk and Resiliency Analysis of Infrastructure by Improving RAMCAP Framework (CAIT-UTC-REG82, Project Manager: Dr. Seyed Hooman Ghasemi)

Outputs: This project will develop a comprehensive risk and resilience assessment framework for critical transportation and coastal infrastructure using the RAMCAP framework.
Outcomes: The framework will identify potential risks to the infrastructure and analyze its resilience against natural and artificial hazards.
Impacts: This research can provide valuable insights into critical transportation and coastal infrastructure risks and develop a comprehensive framework for assessing these factors.

Education and Workforce Development Activities
The consortium has trained 1,381 professionals during this period.

- **Classes, Seminars, and Educational Opportunities**
  CAIT hosted the inaugural Emergency Responder Transportation Safety Research Summit this November in collaboration with TRB's Joint-Subcommittee on Emergency Response AMR00(1). The conference was designed to engage

  emergency response professionals who may not regularly attend TRB's Annual Meeting in January, gather their feedback, and elevate priority areas identified for responder safety and efficacy to new levels. 40+ EMS and transportation professionals attended.

  CAIT completed Year One of its *North American Regional Training Center (NARTC)* workforce development program in collaboration with NJ TRANSIT and UITP. Year one included 6 courses covering everything from E-bus Planning to Rail Maintenance and Fare Management, and reached 200+ transit professionals from NJ Transit, New York City Transit, WMATA, and STM-Montreal among other agencies.

- **Technology and Tools**
  Researchers at CAIT's DataCity Smart Mobility Testing Ground have now generated extensive "Data Hubs," high-resolution smart mobility datasets, from years of data collection throughout the New Brunswick, NJ corridor. The high-resolution vehicle and pedestrian trajectory data collected enables a wide range of R&D and application testing for

industry interested in smart mobility and intelligent transportation systems. CAIT is forming an innovative Public-Private-Academic Alliance with Middlesex County, industry members, and community stakeholders to utilize these datasets in brewing new technologies and building an innovation economy in NJ.

Technology Transfer

- **Presentation and Events**
  CAIT and its Rutgers Rail Lab hosted The Federal Railroad Administration's "Grade Crossing Safety & Railroad Trespass Prevention Workshop" in February. **Amit Bose, FRA Administrator**, and **Parth Oza, NJDOT Asst. Commissioner**, gave opening remarks. The event brought together industry experts to discuss the latest technology and approaches for preventing railroad fatalities. CAIT researchers shared their innovative research deploying AI-powered detection systems for trespass mitigation at rail-grade crossings.

  CAIT's Engineering Research Project Manager, Maurizio Morgese, recently delivered a lecture at the Politecnico di Torino (Italy). Dr. Morgese shared insights and expertise on CAIT projects as part of the course curriculum covering Intelligent Infrastructure. The exchange of knowledge and ideas across borders is critical for sharing fresh perspectives, best practices, and developing research partnerships.

  This October NJDOT celebrated its 25th Annual NJDOT Research Showcase. The event was focused on a "Commitment to Safety" and attended by hundreds of NJ transportation professionals. CAIT faculty presented and won an award for innovative pothole repair research. Director of CAIT's Rutgers Youth Success Program, **Mr. Todd Pisani**, presented a poster on CAIT/RYSP equity work.

- **Research and Publications**
  At the 2023 ASCE International Conference on Computing in Civil Engineering, CAIT researchers shared their work developing an operational framework for identifying safe evacuation and rescue routes in urban environments at risk for catastrophic flood events. This research was published in the conference proceedings. It stems from the UTC project "Assessing and Mitigating Transportation Infrastructure Vulnerability to Coastal Storm Events," where CAIT built a digital twin of the heavily-impacted Manville Township, NJ, and a hydrodynamic flood model to assess flood impacts and future risk.

- **CAIT Students Win Awards**
  Holly Josephs, an engineering doctoral student at Rutgers, was recognized as CAIT's Outstanding Student of the Year during the CUTC awards banquet this January. Holly studies

how riverine and coastal flooding affects buildings, infrastructure, access to emergency services, and transportation networks. She was part of a Rutgers team that helped NJ officials assess flood damage following Hurricane Ida—surveying the damage with drones and lidar systems, gathering data, and building digital twins and flood prediction models.

CAIT and Rutgers Engineering student Bingyan Cui was selected as the first-place winner in the Federal Highway Administration's 2023 Long-Term Infrastructure Performance (LTIP) Student Data Analysis Contest. Her contest paper, "Predicting Pavement Deterioration under Climate Change Uncertainty," developed a promising approach for incorporating climate uncertainty into pavement performance prediction. She presented her work at the TRB Annual Meeting this January.

How have the results been disseminated?

CAIT established the Consortium internet site: https://cait.rutgers.edu/. CAIT has distributed The CAIT Update, its monthly E-newsletter, to subscribers in the transportation industry. CAIT has also shared results to the general public through news media. Select media coverage of CAIT and affiliates of the Center includes:

UITP Y1 North American Training Recap Article

iHeartRadio Article

PBS NJ Business Beat Segment

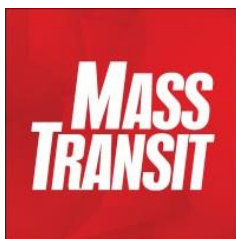Railway Age Magazine

NJDOT 25th Annual Research Showcase Recap

ROI-NJ

Mass Transit Magazine

Rutgers Today Leaders in AI Article

NJBIZ.com

Newsletter
On a regular basis, CAIT has distributed *The CAIT Update*, its monthly E-newsletter, and *The CAIT Seminar Series* to a regional transportation audience of 5,000+ subscribers.

February 2024

CAIT Update
News from the Rutgers Center for Advanced Infrastructure and Transportation

CAIT Awarded $5M USDOT Grant to Build Advanced Bridge Technology Clearinghouse

Leading this effort on behalf of the NCIT UTC consortium, CAIT and its partners will develop a semi-autonomous online portal leveraging Artificial Intelligence to identify innovative bridge technologies and implement them into practice.

Read more

RU Rail Lab Hosts FRA Workshop on Trespassing Prevention and Grade Crossing Safety

From January 30th to February 1st, nearly 200 transportation leaders from agencies across the nation visited Rutgers University to discuss how the rail industry can improve public safety along its thousands of track miles.

Read more

Meet CAIT's 2023 Outstanding Student of the Year: Holly Josephs from Rutgers University

When Hurricane Ida struck NJ in 2021 Rutgers researchers went into the field to assess the damage. CAIT's Outstanding Student of the Year Holly Josephs played a critical role in this research. She was recognized By CUTC last month.

January 2024

CAIT Update
News from the Rutgers Center for Advanced Infrastructure and Transportation

CAIT Part of FRA's National University Rail Center of Excellence Led by UIUC

The FRA recently selected the University of Illinois Urbana-Champaign to lead its new Rail Center of Excellence. Joined by Rutgers CAIT and other university partners, this effort establishes a national cluster of experts to advance the safety, efficiency, and reliability of passenger and freight rail transportation.

Read more

TRB GUIDE: See Updates from DataCity and CAIT Researchers at TRB

Rutgers researchers will be presenting their work throughout the 103rd annual TRB meeting this January 7–11, 2024. Among them will be a presentation from CAIT's DataCity Smart Mobility Testing Ground (SMTG) on research assessing the performance of automated vehicles during adverse weather conditions.

Read more

Inaugural First Responder Summit Brings Safety Leaders to CAIT

The two-day conference, hosted with TRB's Joint-Subcommittee on Emergency Response, gathered transportation agencies, police and EMS personnel, industry, and academia to learn about latest technologies being deployed and to better

Faculty & Student Highlights

Rutgers Researchers Receive PHMSA Grant to Improve Pipeline Safety

Engineering Student Wins FHWA's Pavement Data Analysis Contest

NJDOT Highlights CAIT's Strategic Workforce Development Initiatives

What do you plan to do during the next reporting period to accomplish the goals and objectives?
No change to plan and process to accomplish our goals.

1. **PARTICIPANTS AND OTHER COLLABORATING ORGANIZATIONS** (Who has been involved?)
   Consortium Universities Involved
   Rutgers, The State University of New Jersey • Piscataway, NJ 08854 (**LEAD**)
   Atlantic Cape Community College • Mays Landing, NJ 08330
   Columbia University • New York, NY 10027
   Cornell University • Ithaca, NY 14853
   New Jersey Institute of Technology • Newark, NJ 07102
   Polytechnic University of Puerto Rico • San Juan, Puerto Rico 00918
   Princeton University • Princeton, NJ 08544
   Rowan University • Glassboro, NJ 08028
   SUNY–Farmingdale State College • Farmingdale, NY 11735
   SUNY–University at Buffalo • Buffalo, NY 14260

- *What organizations have been involved as partners?*

New Jersey Department of Transportation	Trenton, NJ	Financial support and collaborative research on multiple projects, personnel resources, knowledge exchange
Port Authority of New York and New Jersey	New York, NY,	Collaborative research on multiple projects, personnel resources, knowledge exchange, financial support
New Jersey Board of Public Utilities	Trenton, NJ	Financial support and collaborative research on multiple projects, including PHMSA State Damage Prevention Grant
New York State Department of Transportation	Albany, NY	Financial support, personnel resources, knowledge exchange
NYCDOT-Division of Sidewalk and Inspection Management	New York, NY	Personnel resources, knowledge exchange
Washington State Department of Transportation	Olympia, WA	Personnel resources, knowledge exchange
Port Authority Trans-Hudson	Jersey City, NJ	Personnel resources, knowledge exchange
New York State County Highway Superintendents Association	Oneida and Chemung Counties	Personnel resources, knowledge exchange
New York Association of Town Superintendents of Highways	Canaan, NY	Personnel resources, knowledge exchange
Mistras Group	Princeton Junction, NJ	Personnel resources, knowledge exchange
Arup	New York, NY	Personnel resources, knowledge exchange
New Jersey Department of Community Affairs	Trenton, NJ	Personnel resources, knowledge exchange
Arora and Associates, P.C.	Lawrenceville, NJ	Personnel resources, knowledge exchange
Pennsylvania Department of Transportation	Bridgeville, PA	Personnel resources, knowledge exchange
Puerto Rico Highway and Transportation Authority	San Juan, PR	Personnel resources, knowledge exchange
Federal Highway Administration, Puerto Rico Division	San Juan, PR	Personnel resources, knowledge exchange
North Jersey Transportation Planning Authority	Newark, NJ	Personnel resources, knowledge exchange

Monmouth County Division of Engineering	Freehold, NJ	Personnel resources, knowledge exchange
Rotorcraft	Atlantic city, NJ	Personnel resources, knowledge exchange
The Everett Railroad	Duncansville, PA	Personnel resources, knowledge exchange
NJ Transit Corporation	Newark, NJ	Financial support, Personnel resources, knowledge exchange
American Institute of Steel Construction	Lancaster, PA	Personnel resources, knowledge exchange
Monmouth County Sheriff's Office	Freehold, NJ	Personnel resources, knowledge exchange
Washington State Department of Transportation	Olympia, WA	Personnel resources, knowledge exchange
Federal Aviation Administration	Washington, DC	Personnel resources, knowledge exchange
Middlesex County	Middlesex, NJ	Financial support, Personnel resources, knowledge exchange
JFK International Airport	Queens, NY	Personnel resources, knowledge exchange
Gateway JFK	Queens, NY	Personnel resources, knowledge exchange
AAA Mid-Atlantic	Wilmington, DE	Personnel resources, knowledge exchange
Verizon	New York, NY	Personnel resources, knowledge exchange

- ***Have other collaborators or contacts been involved?***
  Nothing to report

2. **OUTPUTS** (What new research, technology or process has the program produced?)
   Publications, conference papers, and presentations
- Wang, Yifan & Josephs, Holly & Duan, Zhixiong & Gong, Jie. (2024). The impact of electrical hazards from overhead power lines on urban search and rescue operations during extreme flood events. International Journal of Disaster Risk Reduction. 104. 104359. 10.1016/j.ijdrr.2024.104359.

- Josephs, Holly & Gong, Jie & Wang, Yifan & Xia, Jiahao. (2024). Urban Digital Twin-Based Decision Support for Housing Rebuilding Choices in Catastrophically Flooded Communities. ASCE 2023 International Conference on Computing in Civil Engineering. 10.1061/9780784485248.001.

- Guo, Lukai & Wang, Hao. (2024). Optimization and Validation of Piezoelectric Cantilever Designs for Energy Harvesting from Bridge Vibrations. Transportation Research Record Journal of the Transportation Research Board. 2678. 251-265. 10.1177/03611981231173633.

- Wang, Yifan & Gong, Jie & Josephs, Holly & Duan, Zhixiong. (2024). A Computational Framework for Identifying Safe Evacuation and Rescue Routes in Catastrophic Urban Flooding Environments. ASCE 2023 International Conference on Computing in Civil Engineering. 10.1061/9780784485248.017.

- Zhang, Terry & Jin, Peter & Piccoli, Benedetto & Sartipi, Mina. (2024). Deep spatial-temporal embedding for vehicle trajectory validation and refinement. Computer-Aided Civil and Infrastructure Engineering. 10.1111/mice.13160.

- Zhu, Y., Ni, K., Li, X., Zaman, A., Liu, X., & Bai, Y. (2024). Artificial Intelligence Aided Crowd Analytics in Rail Transit Station. *Transportation Research Record*, *2678*(2), 481-492. https://doi.org/10.1177/03611981231175156

- Yuan Cao, Xiang Liu, Guo Xie, Clive Roberts. (2024) AAP – Technology in rail safety – Applications of advanced technologies in rail safety, Accident Analysis & Prevention. Volume 195. 107152. 10.1016/j.aap.2023.107152.

- Alfaris, Ruqaya & Patel, Deep & Jalayer, Mohammad & Meenar, Mahbubur. (2023). Barriers Associated with the First/Last Mile Trip and Solutions to Bridge the Gap: A Scoping Literature Review. Transportation Research Record: Journal of the Transportation Research Board. 2678. 10.1177/03611981231170184.

- **Policy Papers**
  Nothing to report
- **Website(s) or other Internet site(s)**
  https://www.facebook.com/RutgersCAIT/
  https://www.linkedin.com/company/center-for-advanced-infrastructure-and-transportation-cait
- **New methodologies, technologies or techniques**
  Incorporated into earlier sections of this report
- **Inventions, patents, and/or licenses**
  Nothing to report
- **Other products**

Outputs	Annual Goal	Semi-Annual Metric
1) a traditional or online training program.	3	7
2) a presentation and/or webinar.	10	9
3) a demonstration and/or pilot project.	3	2
4) a guidebook or similar publication in addition to an academic report.	8	5
5) a new specification.	1	1
6) new software or an app.	3	2
7) a new material and/or tangible product.	1	4
8) a potential patent or otherwise marketable product.	2	1
9) Primary or secondary customers will be tracked.	15	4
10) Implementation stakeholders will be tracked.	15	5
11) Implementation stakeholders that identify in each of the following will be tracked.	Customer / Implementer	Customer / Implementer
a. Sponsors of research and T2	2 / 2	1/2
b. Researchers and/or developers	1 / 5	2/4
c. Early adopters and problem owners	5 / 5	1/3
d. Late adopters that follow the technology's development	3 / 5	3/2
e. Deployment team	3 / 3	0/3
f. Others, e.g., trade organizations, regulators, suppliers, etc.	1 / 3	1/2
12) Conceptual methodologies to calculate actual impact. How the PI expects to calculate the actual impact that a customer will realize by implementing the results.	15	3
13) The number of projects that help meet each USDOT Strategic Plan goal	-	-
a. Safety: Reduce transportation-related fatalities and serious injuries across the transportation system.	5	1
b. Infrastructure: Invest in infrastructure to ensure mobility and accessibility and to stimulate economic growth, productivity, and competitiveness for American workers and businesses.	5	0

c. Innovation: Lead in the development and deployment of innovative practices and technologies that improve the safety and performance of the nation's transportation system.	5	1
d. Accountability: Serve the nation with reduced regulatory burden and greater efficiency, effectiveness, and accountability.	2	1

3. OUTCOMES (What outcomes has the program produced?   How are the research outputs described in section (3) above being used to create outcomes?

Outcomes	Annual Goal	Semi-Annual Metric
1) MOU/letters of commitment indicating a customer's commitment to adopt or that they have adopted/used	5	3
2) full-scale adoption of a new technology technique, or practice, or the passing of a new policy, regulation, rule making, or legislation including commercialized or patented product	5	1

4. IMPACT (What is the impact of the program? How has it contributed to improve the transportation system: safety, reliability, durability, etc.; transportation education; and the workforce?)

Impacts	Annual Goal	Semi-Annual Metric
1) cost savings (time, money, or life-cycle performance)	$280k year one - $2.575M each subsequent year	$4,097,596
2) durability and/or resilience and/or preservation	Zero in year one - 30 years each subsequent year	46 years
3) workforce proficiency or documented success stories	4 success stories	8

5. CHANGES/PROBLEMS
- *Changes in approach and reasons for change.*
  Nothing to report
- *Actual or anticipated problems or delays and actions or plans to resolve them.*
  A decline in international students prolonged by the pandemic has at times caused delays in engaging students on research. Labor shortages have also caused project management delays for research stakeholders, at times pushing back project timelines. CAIT has mitigated these challenges by building diverse teams, maintaining close communication with stakeholders, and efficiently leveraging resources throughout the Region II Consortium.
- *Changes that have a significant impact on expenditures.*
  Nothing to report
- *Significant changes in use or care of animals, human subjects, and/or biohazards.*
  Nothing to report