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**TTI's Facilities Help Shape the Future of Transportation** 



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Publisher/Agency Director Gregory D. Winfree

Editor/Managing Editor Chris Sasser/Jack Wenzel

**Copy Editor** Michelle Benoit

**Proofreaders** Dawn Herring Nancy Mathews

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#### Writers Shelby Bruffett Stephanie Ferguson Bernie Fette Haley Layhew Chris Pourteau Chris Sasser Jack Wenzel

Art Director Vicky Nelson

**Designer** Stacy Schnettler

Photographers Richard Badillo James Lyle

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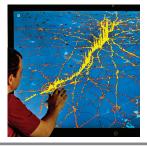
# **TTI Facilities**

### BY RESEARCH AREA

# The Texas A&M Transportation Institute (TTI) stands as a renowned institution at the forefront of cutting-edge

transportation research. With world-class facilities and multidisciplinary expertise, TTI is a global leader in shaping safer, more efficient and environmentally sustainable transportation systems. Through innovative facilities in connected transportation, infrastructure, safety, environment and traffic operations, TTI pushes the boundaries of knowledge, delivering impactful solutions to address the evolving challenges of the industry. Collaborating with industry partners and government agencies, TTI's work yields tangible benefits, transforming the way we navigate and engage within transportation networks.

> **Connected Transportation:** TTI pioneers intelligent transportation systems, vehicle-toinfrastructure communication and autonomous vehicle technology to shape safer and more efficient transportation systems.



Safety

Texas A&M Transportation Institute

**Traffic Operations:** TTI optimizes traffic operations to improve the flow of transportation networks, focusing on traffic management systems, congestion mitigation and data-driven decision-making tools.

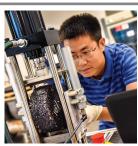
Environment

**Operations** 





**Safety:** TTI's research reduces injuries and saves lives by investigating traffic crash causes, designing safety countermeasures, and promoting safe driving behaviors.









Infrastructure: TTI extends the lifespan and reliability of critical infrastructure through innovative materials, construction techniques and maintenance strategies.







# **Driving Innovation Forward:** *TTI's EERF Unveils New Cutting-Edge Capabilities*

#### Accounting for about 29 percent of the total greenhouse gas (GHG) emissions, the transportation sector is the largest contributor of GHG emissions in the United States. In

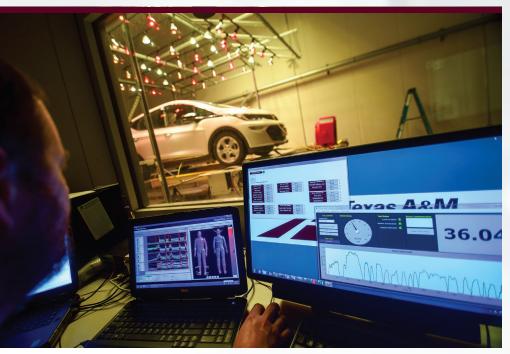
an effort to reduce those numbers, the Texas A&M Transportation Institute's (TTI's) Environmental and Emissions Research Facility (EERF) has emerged as a leader in the race to find more sustainable transportation solutions and it's not quite done growing yet.

Equipped with one of the largest drive-in environmental chambers in the United States, the EERF provides a space for groundbreaking emissions and fuel efficiency research. A one-ofa-kind facility, it focuses largely on studying the emissions of large vehicles — such as tractor-trailers and buses — and finding ways to reduce their environmental impact. "Through the EERF, we are making significant strides in addressing the environmental challenges posed by the transportation sector. We are focused on studying the emissions of large vehicles and helping both the public and private sector test solutions to reduce their environmental impact. The EERF's unique capabilities allow us to conduct groundbreaking research and develop innovative solutions that will drive sustainability forward in the transportation industry."

Jeremy Johnson TTI Research Specialist

"Through the EERF, we are making significant strides in addressing the environmental challenges posed by the transportation sector," says TTI Research Specialist Jeremy Johnson. "We are focused on studying the emissions of large vehicles and helping both the public and private sector test solutions to reduce their environmental impact. The EERF's unique capabilities allow us to conduct groundbreaking research and develop innovative solutions that will drive sustainability forward in the transportation industry."

Originally constructed in 2010 in Bryan, Texas, the EERF is a state-of-the-art facility that can house and test full-size vehicles in a controlled environment. Featuring a 75-foot-long environmental chamber that can simulate various driving conditions — such as extreme temperatures and humidity levels — the

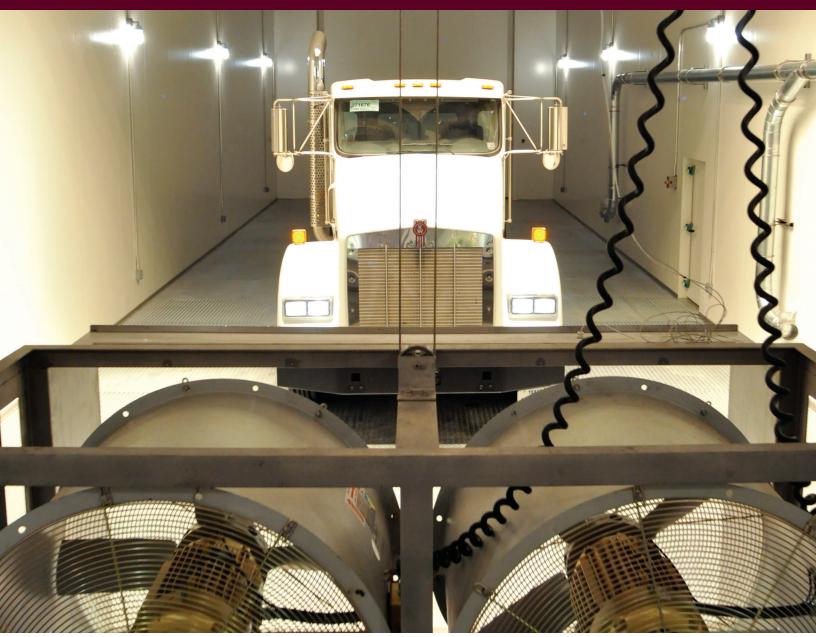


The EERF offers numerous additional opportunities for research and testing new vehicles, components and automotive products, as well as many other products, for their durability under severe temperature, humidity and other weather-like conditions.

facility is unlike any other in the nation. Additionally, the EERF offers opportunities for testing new vehicles, components, automotive products and many other products. This year, the EERF unveils the exciting renovations that will allow researchers to drive sustainability forward.

Funded through the Governor's University Research Initiative (GURI), in a partnership between TTI, Texas A&M University's Department of Electrical and Computer Engineering, and the Texas A&M Engineering Experiment Station, the EERF is transforming its facilities to feature a handful of new assets. They include the following:

• Upgrading the original environmental chamber, the EERF showcases the installation of new equipment including a



The facility is large enough to hold a heavy-duty 18-wheeler and includes offices and a research and testing preparation area.

system for additional cooling capacity that will allow the facility to reach temperatures as low as  $-40^{\circ}$ F and a new dynamometer, which allows for vehicles to be driven inside the chamber.

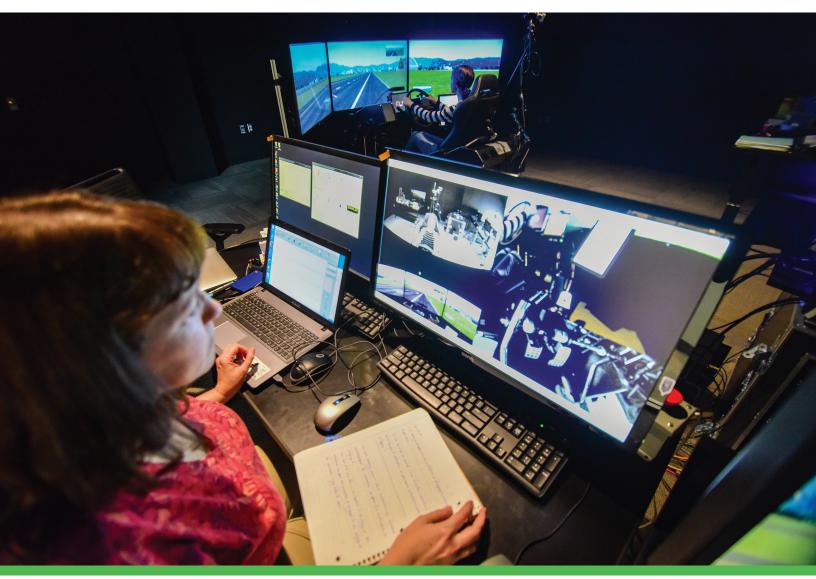
- Housed next to the original EERF facility, a new building is scheduled to open in 2023. This building will feature a new power laboratory and a smaller testing chamber and will focus on transportation, especially electrified transportation, and the impact it has on the grid.
- The GURI grant will also include a solar field at the EERF location that will unlock new charging capabilities and electric-vehicle testing.

The addition of these cutting-edge innovations will continue to help put TTI at the forefront of developing sustainable transportation solutions. "The modifications to the EERF represent a significant milestone in our pursuit of sustainable transportation," says TTI Agency Deputy Director Joe Zietsman. "With the expanded environmental chamber, we can now conduct even more comprehensive emissions, fuel efficiency and energy consumption testing. These enhancements provide us with exciting prospects for electric-vehicle testing and charging capabilities. The advancements made by the EERF position TTI and its partners at The Texas A&M University System as a leader in the development of sustainable transportation solutions, playing a vital role in reducing greenhouse gas emissions and promoting a greener future."



For more information, contact Jeremy Johnson at j-johnson@tti.tamu.edu or Joe Zietsman at j-zietsman@tti.tamu.edu.

# NAVIGATING THE FUTURE: TTI's Driving Simulator Presents New Research Opportunities



TTI's Driving Simulator helps researchers learn how drivers interact with on-road situations, in-vehicle technologies and more.

Revolutionary advancements in vehicle technology and the changing dynamics of the modern roadway system have propelled the act of driving into uncharted territories, demanding a profound transformation in the driving experience. The current technological landscape — with its manifold innovations and tantalizing prospects on the horizon — holds the potential to revolutionize road safety and streamline efficiency. However, this brave new world of driving necessitates the need for drivers to equip themselves with a comprehensive understanding of these innovative systems to effectively safeguard not only their own well-being but also the lives of those who share the road with them.



#### **Case Study:**

TTI and Exponent Inc. undertook a series of driving simulator studies funded by the National Highway Traffic Safety Administration to investigate the relationship between drivers' mental models of automated driving systems (ADS) and the development of appropriate or inappropriate trust in ADS. The simulator presented diverse warning signals and other feedback during driving scenarios to observe participants' responses and interactions with those signals. Additionally, a texting-while-driving task was introduced to divert drivers' attention from the road, allowing for an examination of the varying degrees of automation involved.

"The driving simulator's primary objective is to enhance the safety of our nation's roadways through an understanding of the interplay between a driver's understanding and the surrounding road environment. By providing a controlled setting, the simulator offers a distinctive avenue for examining driver behavior and performance, enabling us to gain valuable insights into their responses to various stimuli. It is these results that help us to identify ways to directly impact the safety of drivers."

#### Michael Manser

TTI Senior Research Scientist and Center for Transportation Safety Division Head

The Texas A&M Transportation Institute's (TTI's) Center for Transportation Safety (CTS) is home to a Realtime Technologies driving simulator, which offers a state-of-the-art driving simulation platform for conducting research in human factors, driver behavior and safety technology development. The simulator provides a safe and controlled environment, which is ideal for exploring a wide variety of driver-, vehicle- and infrastructure-related research questions surrounding drivers' mental models (i.e., the way a person thinks the world operates) and trust about using vehicle automation.

"The driving simulator's primary objective is to enhance the safety of our nation's roadways through an understanding of the interplay between a driver's understanding and the surrounding road environment," emphasizes Michael Manser, director of CTS. "By providing a controlled setting, the simulator offers a distinctive avenue for examining driver behavior and performance, enabling us to gain valuable insights into their responses to various stimuli. It is these results that help us to identify ways to directly impact the safety of drivers."

The simulator is equipped to gather a wide range of driving data, encompassing vehicle speed, acceleration, lane position, proximity to specified objects or roadway elements, and inputs to the steering wheel, brake and accelerator pedal. By programming the simulator's automated vehicle technologies to emulate various levels of automation ranging from level one (lane keeping and adaptive cruise control) to levels four and five (full automation) - researchers can conduct a comprehensive exploration of drivers' mental and physical responses at each stage. This comprehensive examination plays a

vital role in understanding the development and maintenance of mental models across the entire spectrum of automation.

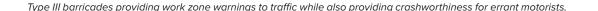
Other data collection systems can be used in conjunction with the simulator to provide additional information about driver behavior and responses in real-world driving situations, including

- eye tracking to record the driver's glance patterns;
- an infrared thermal camera and physiological monitors (heart rate and galvanic skin response) to measure stress responses; and
- face, hand and foot cameras to see driver responses that may not be captured by the simulator.

"The ability to simulate a wide range of driving conditions and scenarios makes it an invaluable tool for improving road safety and developing new countermeasures to help prevent crashes," notes Robert Wunderlich, TTI senior research engineer. "The driving simulator provides a controlled and safe environment to evaluate new vehicle technologies that are intended to ensure that road users are safe on our roadways today, tomorrow and in the foreseeable future." ■



For more information, contact **Michael Manser** at <u>m-manser@tti.tamu.edu</u>. TTI's Roadside Safety and Physical Security Division Spearheads Safety and Security Transportation Advancements



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At the heart of the TTI Proving Grounds lies the unique testing infrastructure. The facility features a large area of concrete runways and aprons, enabling researchers to study various roadway conditions, including the completion of high-speed, full-scale crash tests.



#### The Texas A&M Transportation Institute's (TTI's) Roadside Safety and Physical Security Division has been protecting occupants from roadside hazards since the 1960s. From the early days, this facility

— located on the Texas A&M-RELLIS campus — has served as a test site for countless research projects improving both safety on the roadways and security of critical infrastructure. While technology has evolved over the years, some core principles have remained the same. "We're a family of wideranging, highly skilled individuals that come together to promote safety on our roadways and provide a great service to our sponsors," says TTI Assistant Research Scientist Jim Kovar. "While the early days involved connecting oil drums to form the first crash cushions, the team has evolved into an ISO 17025–accredited laboratory offering a diverse range of testing environments, advanced equipment and expert personnel."

The Roadside Safety and Physical Security Division is comprised of three programs: the TTI Proving Grounds, the Roadside Safety Program and the Infrastructure Protection Program. These programs serve as a hub

for collaboration with industry partners, academic institutions, government agencies and research organizations.

#### **TTI Proving Grounds**

At the heart of the TTI Proving Grounds lies the unique testing infrastructure. The facility features a large area of concrete runways and aprons, enabling researchers to study various roadway conditions, including the development of roadside safety hardware such as guardrails, bridge rails, crash cushions, and sign and luminaire supports. TTI researchers perform full-scale, high-speed crash tests on these roadside safety devices and perimeter security devices. The runways and aprons incorporate diverse surface materials, gradients and intersections that offer an accurate representation of real-world conditions. The Proving Grounds also includes specialized V-shaped ditches, allowing researchers to conduct advanced roadside hardware assessments and vehicle transversability studies. Researchers also use a series of surrogate vehicles, which provide a cost-effective and reusable method for component testing.

TTI's ISO 17025–accredited Proving Grounds laboratory provides testing and evaluation services for the division's research projects. Testing has included evaluating a wide range of vehicle sizes, from a seated motorcyclist to a fully loaded 80,000-pound tractor with semi-trailer. The Proving Grounds ISO 17025 accreditation provides testing services compliant with a wide range of standards, including American Association of State Highway and Transportation Officials, ASTM International and American National Standards Institute (ANSI)



5,000-pound pickup truck impacts asphalt-pavement-mounted concrete barrier at 62 miles per hour.

requirements. Various states, federal agencies and private industry entities have contracted with TTI researchers and the Proving Grounds to receive assistance with product development and compliance crash testing.

#### **Roadside Safety Program**

The Roadside Safety Program's primary objective is to develop effective roadside safety solutions that reduce the significant number of fatalities and serious injuries experienced from roadside departures and crashes on our nation's highways.

"The leading cause of fatalities or serious injuries is runoff-the-road crashes," says Kovar. "While rumble strips and wide shoulders are the first line of defense in keeping people safe and on the roadway, our division's work is the last line



Noise abatement and roadway departure mitigation: 80,000-pound tractor-trailer contained by concrete barrier and soundwall.

curity

The Roadside Safety and Physical Security Division is comprised of three programs: the TTI Proving Grounds, the Roadside Safety Program, and the Infrastructure Protection Program. These programs serve as a hub for collaboration with industry partners, academic institutions, government agencies and research organizations. of defense before encountering a roadside hazard. From steel guardrails to concrete median barriers, it's hard to drive a mile on Texas roadways without seeing hardware that has been tested or evaluated by the Roadside Safety Program."

#### Infrastructure Protection Program

The Infrastructure Protection Program's primary objective is protecting critical infrastructure from threats and hazards. Through research, analysis and innovative strategies, the program enhances the security of roads, bridges, tunnels and other vital infrastructure components of the transportation network, ensuring functionality and safety.

The program started as the Physical Security Program, which focused on mitigating vehicular ram attacks on high-risk targets. This included developing bollards, gates and concrete solutions for mitigating a vehicle ram attack. Recently, the program was renamed the Infrastructure Protection Program with an expanded scope of focusing on other types of protection for our nation's critical infrastructure, such as disaster resilient barriers.

#### **Program Collaboration**

All three programs continue to advance technology and procedures to address emerging needs. The Roadside Safety and Physical Security Division has positioned itself to be the nation's leading research group for evaluating motorcycle impacts with the newly formed Development and Evaluation of Roadside Safety Systems for Motorcyclists Pooled Fund. Researchers have also assisted in authoring the ANSI MH31.2-2021 Test Method for Crash Testing Industrial Guardrail Barriers and Barrier Posts, and the Roadside Safety and Physical Security Division is the lead testing facility. Additionally, the division has researchers who



Roadside Safety and Hydraulic Drainage: TTI Proving Grounds researchers evaluate a concrete barrier with drainage structures with an impacting 5,000-pound pickup.

review and inspect adaptive equipment vehicle modifications performed for people with physical disabilities, in cooperation with the Texas Workforce Commission.

The collaborative environment between the three programs encourages the development of solutions that address challenges in transportation, making the division a recognized leader in the areas of roadside safety and physical security design, analysis, testing, and evaluation. Through its ongoing efforts, the division continues to shape the future of transportation by developing innovative technologies and practices that improve safety and efficiency.



For more information, contact Lance Bullard at I-bullard@tti.tamu.edu.



Low-profile barrier provides vehicular protection in work zones.

"The leading cause of fatalities or significant injuries is run-off-the-road crashes. While rumble strips and wide shoulders are the first line of defense in keeping people safe and on the roadway, our division's work is the last line of defense before encountering a roadside hazard. From steel guardrails to concrete median barriers, it's hard to drive a mile on Texas roadways without seeing hardware that has been tested or evaluated by the Roadside Safety Program."

Jim Kovar TTI Assistant Research Scientist



## Seeing the Road — TTI'S VISIBILITY RESEARCH LABORATORY BUILT FOR VISIBILITY TESTING

#### Seeing the road and everything

around it while driving is not a *preferred* option; rather, it's an essential component of safe driving. Driving is a visual activity, and as we make our way down a road, we all look at a wide range of visual inputs — the roadway, the surrounding terrain, other vehicles, roadside buildings, advertisements, and traffic control devices such as signs, markings and signals — to help us get where we're going. How we distinguish those visual inputs and maneuver the vehicle safely varies from person to person and can depend on quite a number of random, uncontrollable things — the weather, time of day, driver age, health and experience, as well as unexpected distractions inside or outside the vehicle — all can have an effect.

For over two decades, the Texas A&M Transportation Institute (TTI) has developed innovative ways to improve visibility in nighttime driving and has played a major role in standardizing visibility test methods. That dedication to finding solutions has resulted in the development of TTI's Visibility Research Laboratory, located on the first floor of TTI's State Headquarters Building on the Texas A&M-RELLIS campus.



The lab has been used to measure the visibility of traffic control devices, retroreflective and luminescent materials, and light sources such as work zone lighting, light-emitting diodes and vehicle headlamps.

TTI's Visibility Research Laboratory is the first of its kind in a university setting. The lab features a 140-foot-long by 15-foot-wide corridor for testing retroreflective materials as well as coatings, lights and other technologies designed to provide nighttime visibility. The lab also has ventilation systems to allow full-size vehicles to run in the lab while conducting human factors testing and evaluating installed headlamp illumination.

The room was built for future installation of rainmaking equipment to allow assessment of visibility of devices under wet conditions. The 140-foot tunnel-shaped facility also allows researchers to run humansubject night simulation studies under controlled conditions at any time during the day. An adjacent conference room provides space for presentations, where sponsors and visitors can examine samples of reflective materials with microscopes.

"For the last 50 years, TTI researchers have conducted full-scale, closedcourse nighttime driving studies at the RELLIS campus," says TTI Associate Research Engineer Adam Pike. "This outdoor facility allows for static and dynamic visibility and human factors research at speeds of up to 70 miles per hour. The Visibility Research Laboratory complements this full-scale testing facility and allows us to take our visibility research to the next level."



For more information, contact Adam Pike at a-pike@tti.tamu.edu.



# **Pioneering the Future** of Transportation

As the nation grapples with the pressing need for new and improved infrastructure, the Center for Infrastructure Renewal (CIR) stands as a beacon of innovation and research. Located in Bryan, Texas, CIR offers a state-of-the-art facility dedicated to addressing the challenges and demands of modern infrastructure. With a focus on developing sustainable, resilient and efficient solutions, CIR is at the forefront of shaping the future of transportation and infrastructure across the nation.

Funding for CIR was granted by the Texas Legislature in 2015 through a unique partnership between the Texas A&M Transportation Institute (TTI), the Texas A&M Engineering Experiment Station (TEES), the Texas A&M College of Engineering (CoE) and the State of Texas. After approximately 17 months of construction, CIR officially opened its 138,000-square-foot facility in 2018 and has since cemented itself as a center for innovative and transformative research.

"Through CIR, we have created a unique platform that brings together brilliant minds, cuttingedge technology and state-of-the-art facilities," says Anand Puppala, CIR director and professor in Texas A&M University's Zachry Department of Civil and Environmental Engineering. "Our researchers are driven by a common goal: to develop innovative solutions that not only address the current infrastructure needs but also pave the way for a sustainable and resilient future. Their work is a testament to our commitment to shaping a better tomorrow for our communities."

With such a unique and robust workforce across TTI, TEES and CoE, CIR offers 12 state-of-the-art laboratories focused on conducting research across nine critical infrastructure sectors: transportation systems, chemical, communications, critical manufacturing, smart energy, information technology, nuclear reactors, materials and waste, and water and wastewater systems.

CIR will serve as a crucial facility in the next five years for TTI, TEES and CoE as they collaborate with Prairie View A&M University on their National Center for Infrastructure Transformation tier-1 University Transportation Center.



#### Asphalt Innovation Laboratory

The Asphalt Innovation Laboratory accredited by the American Association of State Highway and Transportation Officials includes state-of-the-art equipment and worldclass researchers dedicated to investigating, developing and deploying improvements in asphalt technology. A better understanding of asphalt through the innovations developed in this lab is leading to the development and implementation of pavements that rut and crack less, are longer lasting, and ultimately cost less over their designed life.



#### Geotechnical and Unbound Materials Innovation Laboratory

Infrastructure systems are only as good as the foundation on which they are built. Much of our existing infrastructure is in dire need of foundational upgrades or rehabilitation. The Geotechnical and Unbound Materials Innovation Laboratory allows researchers to investigate soil stabilization and rehabilitation techniques that can be implemented in both the short and long term.

These areas have been identified as critical needs for our nation, and CIR is at the forefront of addressing the challenges and opportunities they present.

"Our state-of-the-art laboratories stand at the forefront of innovation and research," states Edith Arámbula Mercado, CIR deputy director and TTI research engineer. "They are the proving grounds where ideas are materialized and the future of transportation and infrastructure is forged. These laboratories demonstrate our unwavering commitment to shaping a better future through cutting-edge research and collaboration."

As the facility seeks to expand to fulfill the research needs associated with a growing population — and thus an increased strain on the nation's infrastructure — securing new and unique partnerships and providing technology transfer in workforce development are critical topics the center hopes to address in the coming years. To help accomplish these goals, CIR established the CIR Advisory Panel (CAP), comprised of key industry members dedicated to solving industry infrastructure-engineering problems through research and workforce development. CAP members can advocate on future research directions in the infrastructure field and provide networking opportunities as appropriate. "Our state-of-the-art laboratories stand at the forefront of innovation and research. They are the proving grounds where ideas are materialized and the future of transportation and infrastructure is forged. These laboratories demonstrate our unwavering commitment to shaping a better future through cutting-edge research and collaboration."

Edith Arámbula Mercado CIR Deputy Director and TTI Research Engineer

"As the CIR continues to grow, we are actively seeking opportunities to expand our impact and reach," says Charles Gurganus, instructional professor in Texas A&M University's Civil Engineering Department. "We firmly believe in the power of collaboration and acknowledge that by forging partnerships with industry leaders, government agencies and academic institutions, we can drive substantial advancements in infrastructure. With the establishment of new and evolving partnerships — coupled with a forward-thinking workforce — CIR is primed to make significant contributions to the field

of infrastructure, shaping a brighter future for generations to come."



For more information, contact Edith Arámbula Mercado at e-arambula@tti.tamu.edu.

#### Structural and Materials Testing Laboratory

The Structural and Materials Testing Laboratory is one of the largest, best-equipped facilities of its kind in the country. The lab's ability to perform full-scale component and material testing sets it apart. Most institutions must rely on numerical research with small-scale testing, but CIR allows researchers to go one step further and conduct research on structural elements and systems similar to those put into service.



# TTI's Connected Transportation Facilities



A close-up of the toll gantry's plate reader capturing vehicle information.

C onnected transportation is a major evolution in how vehicles and infrastructure will interact in the future, affecting every facet of transportation safety and mobility. Vehicles and the infrastructure will be able to talk to each other and communicate their real-time conditions. The lifespan of this research is expected to be decades as communication and message standards, applications, and new data collection and analysis techniques are developed to bring this transformational technology to the roadways we all drive.

The Texas A&M Transportation Institute (TTI) is poised to lead the way with our living research test beds located at the Texas A&M-RELLIS campus.





In the Connected Infrastructure Laboratory at the Center for Infrastructure Renewal, experts are pioneering next-generation sensors and data applications for the connected and automated vehicle environment.

#### **Connected Infrastructure Laboratory**

The Connected Infrastructure Laboratory is a fully equipped virtual collaborative workspace where different disciplines can work together to develop, test and deploy next-generation sensors and data applications for the connected and automated vehicle environment and the overall infrastructure arena. The facilities are a living laboratory for undergraduate and graduate students as they develop expertise in connected transportation and grow into industry leaders in this emerging discipline.

#### Connected Vehicle Assessment Simulation Test Bed

TTI has the capability to develop an augmented-reality environment where real entities (e.g., vehicles and traffic signal operation) are combined with simulated traffic and displayed on a screen. The first-of-its-kind approach - called Connected Vehicle Assessment Simulation (CONVAS) — marries the cost-effectiveness of computer simulation with actual roadway operations to produce an efficient and dependable evaluation mechanism for the Federal Highway Administration. TTI researchers developed an enhanced hardware-in-the-loop (HITL) simulation by incorporating an actual connected vehicle (CV) on a roadway network into a simulation model and displaying simulated CVs inside the real vehicle at the same time. This enables development and testing of advanced CV applications or strategies by allowing assessments of how CVs respond to each other and other entities such as pedestrians, emergency vehicles and transit vehicles in a controlled environment. This is the first time HITL simulation has ever been applied in this way.



TTI researchers conducted an HITL simulation by integrating real CVs into a simulation model, simultaneously displaying simulated CVs inside the real vehicle.

**CONVAS** marries the cost-effectiveness of computer simulation with actual roadway operations.



A Texas A&M University bus equipped with DSRC radios communicated its turn by activating the "Caution Bus Turning" warning and displaying a bus signal above the pedestrian sign. This Smart Intersection provides pedestrians, bicyclists and e-scooter riders a safer way to cross the street.

#### **Smart Intersection**

TTI's Smart Intersection advances research in traffic signal control, detection technology and CV infrastructure to increase awareness and safety on roadways. Located on the RELLIS campus, the Smart Intersection has a fully actuated traffic signal with signal poles and mast arms, painted pedestrian crosswalks, and a bicycle lane. TTI, Econolite, other vendors and the Texas Department of Transportation (TxDOT) contributed to the intersection installation and additional research equipment. The intersection can accommodate detection and communication equipment for conducting a variety of tests. The intersection also includes flashing yellow arrows on all four approaches; radar detection for the northbound and southbound approaches; video detection for all four approaches; a GRIDSMART<sup>®</sup> system to detect pedestrians, bicyclists and vehicles at the stop bar; and numerous dedicated short-range communications (DSRC) radios constituting the connected infrastructure.

The project developed a concept of operations for buses equipped with DSRC radios to communicate with the traffic signal that an approaching bus was turning.

The Smart Intersection was initially developed as part of the TxDOT Automated and Connected Vehicle Test Bed to Improve Transit, Bicycle and Pedestrian Safety project. The project developed a concept of operations for buses equipped with DSRC radios to communicate with the traffic signal that an approaching bus was turning. The audio message "Caution Bus Turning" in English and Spanish was automatically activated, as was a supplemental bus sign above the pedestrian sign on the traffic pole. The system was demonstrated for a year at the George Bush Drive and Penberthy Boulevard intersection, with 10 Texas A&M University buses equipped with DSRC radios communicating to the traffic signal system.

The Smart Intersection recently supported the Traffic Optimization for Signalized Corridors (TOSCo) project to conduct end-to-end testing of all system components before TOSCo was deployed in real traffic along FM 1960 in Houston. The Smart Intersection will also support the Smarter Intersections Pilot Project recently selected for funding though a Strengthening Mobility and Revolutionizing Transportation grant from the U.S. Department of Transportation.

This Smart Intersection will enable TTI researchers to install additional signal control, detection, DSRC and other connected infrastructure. The Smart Intersection will support research to develop CV applications and to test the interoperability of signal control and connected infrastructure.

#### **Connected Work Zone**

TTI deployed CV technology along the I-35 corridor to improve safety and mobility through work zones by providing in-vehicle devices to freight companies to receive work zone infrastructure data on lane closure location, capacity reduction, queue lengths and delay to assist in pre-trip and en-route planning for logistics.



A two-lane highway narrows to a single lane of traffic due to work zones along I-35. Information regarding traffic conditions throughout I-35 work zones can be assessed through CV technology by providing in-vehicle devices to freight companies.

TTI deployed CV technology along the I-35 corridor to improve safety and mobility through work zones.



Located at the TTI Proving Grounds on the RELLIS campus, the Neology Transportation Research Center will help accelerate the vision for smart cities and safe communities by designing, developing and testing mobility solutions.

#### **Partnership with Neology**

TTI and Neology Inc. recently completed the Neology Transportation Research Center and extended its longterm master research agreement for an additional five years, with an optional five-year extension. The new facilities will help accelerate the vision for smart cities and safer communities by advancing next-generation technologies in the mobility industry.

Neology Inc. is a leading provider of mobility solutions and services in the transportation, tolling and public

Our partner facilities will help accelerate the vision for smart cities and safer communities by advancing next-generation technologies in the mobility industry. transportation, tolling and public safety fields. Powered by artificial intelligence, Neology's solutions and services help improve the safety, security and sustainability of critical infrastructure. The company's mobility experts work closely with

global customers and a partner ecosystem to leverage next-generation technology.



#### **Toll Gantry**

Congress required that by 2016, the tolling industry develop interoperability standards allowing locally issued toll tags to work anywhere in the nation. "We tested a possible solution from two equipment manufacturers," says TTI Associate Research Scientist Roberto Macias. "We used the radio-frequency identification toll tags from various agencies Congress required the tolling industry to develop interoperability standards allowing locally issued toll tags to work anywhere in the nation.

and determined if the tested products could read them and if the vendors could be tied together."

TTI conducted its testing by sending vehicles equipped with various toll tags through a toll gantry equipped with the transponders from the manufacturers.



Vehicles pass through a toll gantry equipped with cameras and plate readers.

For more information, contact Bob Brydia at <u>b-brydia@tti.tamu.edu;</u> Srinivasa Sunkari at <u>s-sunkari@tti.tamu.edu;</u> or Katie Turnbull at <u>k-turnbull@tti.tamu.edu</u>.

# Investigate. Communicate. Innovate.

TTI Assists TxDOT in Sharing Local Solutions Statewide

"Districts focus on solving their local problems, as they should, and they often do that by thinking outside the box and coming up with innovative solutions to a problem they're facing. What we're doing with this project is helping facilitate even more innovations with TxDOT and then get the word out about them across the entire department so that innovations in one district can be expanded to other districts."

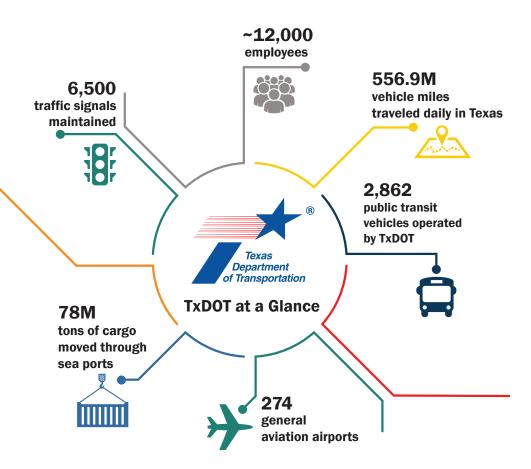
Bob Brydia TTI Senior Research Scientist With more than 12,000 employees and serving a state comprising nearly 270,000 square miles, the Texas Department of Transportation (TxDOT) is responsible for the largest state transportation system in the nation.

To better manage the vastly different mobility needs across the Lone Star State, TxDOT established 25 geographic districts and 34 disciplinary divisions. Organizing personnel in that way allows agency experts — in road maintenance, safety and traffic operations, to name a few areas — to address problems relevant to their region.

TxDOT has launched the Innovative Transportation in Texas program to identify, evaluate and develop innovative solutions to meet the growing transportation needs across the state. In addition to the main goal of fostering innovation, this program will bring together all districts' innovative projects in one database as a shared resource.

"TxDOT continues to lead the way in bringing together new solutions from each district that could be implemented across the entire agency," says Darran Anderson, TxDOT director of strategy and innovation. "This initiative will make TxDOT more efficient and ensure we focus on safety for our users and employees."

For example, maintaining an eight-lane freeway in Houston is a different problem than reducing crashes at rural intersections in West Texas. But that doesn't mean a solution in one region can't be relevant to a problem in another.



Innovation:



The implementation of new ideas, devices or processes that address a problem and create value for TxDOT and its customers.

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"Districts focus on solving their local problems, as they should," explains Bob Brydia, senior research scientist at the Texas A&M Transportation Institute (TTI). "And they often do that by thinking outside the box and coming up with innovative solutions to a problem they're facing. What we're doing with this project is helping facilitate even more innovations with TxDOT and then get the word out about them across the entire department so that innovations in one district can be expanded to other districts."

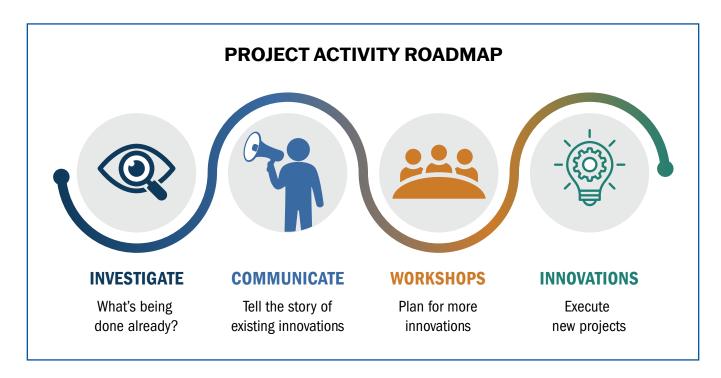
To help TxDOT's districts and divisions learn from one another's applied innovations, TxDOT and TTI developed the Planning Innovation Deployment project. Work began in March 2022 and, due to the success of the program, will continue into 2024. The approach is to

- investigate to determine technological and methodological innovations implemented at the district level,
- communicate those inventions via user-friendly tech transfer tools (e.g., informative flyers and PowerPoint presentations) to build awareness agencywide,
- facilitate district workshops to plan for additional innovations, and
- execute new projects with districts as partners to develop local solutions that have potential statewide application.

TTI leads Kevin Balke, Jim Cline and John Speed join Brydia as principal coordinators of the Institute's efforts on TxDOT's behalf. Working together, the team — which consists of more than 25 TTI subject matter experts — leads workshops, fosters and oversees innovation projects, prepares outreach materials, and advances the department's innovation culture.

One of the first steps was to define *innovation* in a way most relevant to TxDOT. "The agency's strategic goals are focused on making transportation better, more mobile and safer for system users," says Brydia. "Looking at transportation improvements in terms of their value was a necessary first step in helping us define the landscape we're working in."

To date, the project has focused on how deploying new technology can improve traffic operations. For example, during a recent visit to the Yoakum District, the TTI team met with the district leadership, who initially expressed a desire for a system to warn drivers of slowdowns resulting from work zones down the road. Just such a system was developed in recent years as part of the My35 Project in Waco. Called an end-of-queue warning system, it uses real-time data gathering to feed roadside message signs and other information channels, like social media, to help travelers not only plan their trips in advance but



also improve travel time reliability. Most importantly, the system makes drivers aware of those slowdowns, which can save lives by helping avoid unnecessary collisions.

"The district was delighted to hear such a system already exists and has been proven to work effectively," Brydia says. "That's exactly the kind of meeting of the minds we're trying to achieve with this project. Even more importantly, the existing innovation allows TxDOT and TTI to work on the next problem facing the district."

TTI has so far produced summaries on 18 traffic operations innovations across the state. The summaries can be found at TxDOT.gov (see the link at the end of this story). They can be used to answer questions like, "Has anyone addressed this problem before? How was it solved? Will that solution work locally in my area?" The potential for saving untold personnel hours and tax dollars otherwise spent in reinventing a wheel that already exists is clear.

In the future, Brydia hopes to extend the project to document innovations in safety, reliability and congestion, data usage, infrastructure resiliency, and smart transportation solutions. Getting out and talking to folks across the state is essential to the process, he notes.

"To bridge that communication gap I mentioned earlier, TTI is acting as a facilitator across traditional divisional and district lines. We're helping Mary in Lubbock learn what John in Corpus Christi did to fix a problem they both share," says Brydia.



For more information, contact Bob Brydia at r-brydia@tti.tamu.edu.



# Rain or Shine: TTI's SEC Lab Pioneers Roadside Environmental Management

A s the wear and tear of time puts a toll on our roads and our environment, it's imperative to have measures in place to combat potential issues that may arise. With the ever-changing climate and increasing environmental regulations, now more than ever it's essential that the best products are being used on our roadways — not only for the safety of the people on them but for the longevity of our planet.

The Texas A&M Transportation Institute's (TTI's) highly acclaimed Sediment and Erosion Control (SEC) Laboratory houses a wide range of state-of-the-art equipment, including five indoor rain simulators, a physical property test lab, a 1,000-foot vegetated natural soil embankment, a variable slope channel flume, a sediment control device evaluation facility and pollinator test plots. Together, these one-of-a-kind assets have helped TTI conduct extensive research on erosion and sediment control, stormwater quality improvement, vegetation establishment, animal conservation and more.

"One of our most prominent projects in the facility has been developing the Interactive Approved Product List for Erosion and Sediment Control Products. This tool helps engineers and designers select the best management practice based on user input of site conditions," says TTI Associate Research Scientist Jett McFalls. "However, with the versatility of the lab, it also affords us the opportunity to take on different projects that address the impacts transportation has on our environment."

Originally built in 1990, the SEC Lab has been in operation for over 30 years and has earned international recognition for its research and testing capabilities. SEC Lab projects include state and federal research projects for the Texas Department of



The SEC Lab houses five indoor rain simulators, a physical property test lab, a 1,000-foot vegetated natural soil embankment, a variable slope channel flume, a sediment control device evaluation facility and pollinator test plots.



The 30-foot outdoor variable slope channel flume is used for evaluating the performance capabilities of flexible channel liner materials at a range of shear stress flows.

Transportation, Federal Highway Administration, American Association of State Highway and Transportation Officials, National Cooperative Highway Research Program, Transportation Research Board, Texas Commission on Environmental Quality and various state departments of transportation. The SEC Lab recently received the International Erosion Control Association's Environmental Excellence Award.

A 19-acre indoor and outdoor facility operated by TTI's Multimodal Planning and Environment Division, the laboratory tackles roadside environmental management issues and conducts comprehensive product testing. A highly sought-after facility, the laboratory underwent a major expansion in 2013 to increase efficiency and sustainability in the face of demand. The expansion brought with it a brandnew building with three independently operated indoor rainfall simulators equipped with three 8-by-40-foot variableslope soil-filled test beds, a 1,500-foot covered sediment bed preparation area and a 40-by-60-foot soil storage building. Today, the SEC Lab continues to act as a key resource for infrastructure and development projects.

"Over the years, the lab has provided the transportation industry with valuable information and solutions to the challenges posed by modern infrastructure issues," notes McFalls. "The facility has provided us with a scientifically

sound platform to push the boundaries of testing, which has led to significant cost savings, greater environmental protection and more resilient roads." ■



For more information, contact Jett McFalls at j-mcfalls@tti.tamu.edu.

# TTI NEWS

#### Captain Clyde A. Barbour Inducted into Texas Transportation Hall of Honor

**C**aptain Clyde A. Barbour was posthumously inducted into the Texas Transportation Hall of Honor at a luncheon on June 26 at Sylvan Beach Pavilion in La Porte, Texas, near his namesake facilities: Barbours Cut inlet and Barbours Terminal at Port Houston. He was nominated by his greatgranddaughter, Nancy Potter, who accepted the honor on Barbour's behalf.

A young and ambitious steamboat captain and resident of Houston for 20 years in the early 1900s, Barbour recognized the potential for expanding waterborne commerce in the Houston Ship Channel. He envisioned and undertook a bold endeavor to cut the five-hour trip in half for ships traveling from the Gulf of Mexico to Port Houston. He accomplished this by dredging an inlet that included a turning basin off the Houston Ship Channel only two and a half hours from the Gulf of Mexico. He named the inlet and terminal Barbours Cut and Barbours Terminal, respectively.

His ambitious project catapulted Port Houston to the forefront of container activity in the Gulf Coast and helped transform the port into the fastest-growing



L to R: Texas A&M Transportation Institute Director Greg Winfree; Nancy Potter; Port Houston Executive Director Roger Guenther; and Port Houston Commisioner Clyde Fitzgerald.

container port in the United States and the first in overall tonnage.

Barbour also owned the Galveston, Harrisburg and Houston Transportation Company, as well as other companies, and was awarded the contract in 1910 to supply concrete for the first great causeway over Galveston Bay between Galveston Island and the mainland. This contract helped make building materials one of the largest branches of trade in Houston. ■

#### Texas A&M System Agencies Work Together to Make History on Recent UTC Proposals

The United States Department of Transportation (USDOT) recently announced grant awards for eight University Transportation Centers (UTCs) in which Prairie View A&M University (PVAMU), the Texas A&M Engineering Experiment Station (TEES), TTI and Texas A&M University will lead or assist over the next five years. Of historical note is PVAMU's selection to lead the National Center for Infrastructure Transformation, making the institution the first-ever Historically Black College or University to lead a national UTC.

The National Center for Infrastructure Transformation will "develop and transfer into practice new technologies or approaches not currently deployed in the transportation system, including novel data and technology approaches related to artificial intelligence and environmental stewardship and resilience," according to USDOT. The work of the center will aim to improve the durability and resiliency of transportation infrastructure for years to come. In addition to serving in consortia on PVAMU's national UTC, TEES, TTI and Texas A&M will collectively serve as partner institutions on six tier-1 UTCs and one regional UTC, headlined by the renewal of the TTI-led Center for Advancing Research in Transportation Emissions, Energy and Health tier-1 UTC. Research priorities for these seven UTCs will each address one of the following areas:

- improving the durability and extending the life of transportation infrastructure,
- conducting coastal research and education,
- improving the mobility of people and goods,
- preserving the existing transportation system, and
- promoting safety.



For more information, contact Bernie Fette at b-fette@tti.tamu.edu.





# A (Research) House Is Not a Home

We've devoted much of this edition of our magazine to showcasing some of the most advanced transportation research facilities anywhere on the planet. Throughout its history, TTI has devoted significant financial investment to building and continually refining these spaces to ensure that our laboratories are every bit as monumental as the transportation challenges they're designed to address.

The problem-solving tasks that we face are frequently enormous in both scale and significance; the places where we pursue that work must be equally ambitious. And so they are.

We are understandably proud of our research facilities, but we are at the same time keenly aware of how those places would be mere shells without the talent and commitment of the people who labor within them each day.

The same is true of so many other fields.

Consider, for instance, the grandeur of Carnegie Hall. It's an architectural masterpiece – a hallowed venue that seeks to reach vast audiences through the transformative power of music. But without the masters who deliver that music, the facility is nothing more than an opulent arena taking up space and serving little useful purpose at a busy Manhattan intersection.

Consider also the greenhouses at Texas A&M University. Tens of thousands of square feet of



I feel pretty much the same when I consider our vast and varied research facilities at TTI. As places that welcome curiosity and enable discovery, they constitute a house where magical things can happen. But in the end, it's TTI's magical people who make our house a home.

experiment-ready testing space offer testament to the school's earliest days as an epicenter of agricultural discovery. Without the scientists and technicians who nurture and bring improvement to what evolves there, these spaces would be mere hulking carcasses.

And just so we have a transportation example, let's consider the space shuttle. Mere words fail in any attempt to adequately describe the brilliant scientific supremacy or the immense power of this craft, weighing more than 4 million pounds and capable of speeds beyond 17,000 miles per hour. But where would it go without human involvement? I speak not only of those who pilot the shuttle but also the scores of professionals who staff the control base to ensure that the mission is safe, or spring into crisis mode when it's suddenly not.

I think Luther Vandross had it right when he sang, "A chair is still a chair, even when there's no one sittin' there, but a chair is not a house, and a house is not a home."

I feel pretty much the same when I consider our vast and varied research facilities at TTI. As places that welcome curiosity and enable discovery, they constitute a house where magical things can happen. But in the end, it's TTI's magical people who make our house a home. ■





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https://tti.tamu.edu/thinking-transportation/

**Stream Now** 

#### Is America's Infrastructure **Turning a Corner?**

#### Featuring: Charles Gurganus and Nasir Gharaibeh

Two years have passed since America's last road and bridge report card, and we'll wait another two years for the next one. An unofficial mid-

term grade suggests that conditions are improving.



### **Charging Ahead: How the Electrified Mobility Collaborative Envisions a Radical Shift**



#### Featuring: Tara Ramani

Nearly 300 million vehicles are on American roads today. Nearly all of them run on gasoline or diesel, so a large-scale shift to electric power would be transformative. A new Texas A&M University System venture is working to figure out how that might work.

