TTI–Texas A&M Engineering Collaborations Enhance Educational Opportunities

Texas A&M, TTI, TEES Partner in Campus Transportation Technology Initiative

TTI, Texas A&M Law School Work to Navigate the CV/AV Policy Maze

TEXAS TRANSPORTATION

Researcher

VOL. 53 | NO. 1 | 2017

EXPANDING OUR REACH

Texas A&M Transportation Institute

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Researcher
VOL. 53 | NO. 1 | 2017

ON THE COVER: The Texas A&M Transportation Institute reaches out to students across multiple disciplines — engineering, planning, environmental and others — to educate the next generation of professionals who will solve tomorrow's transportation challenges.

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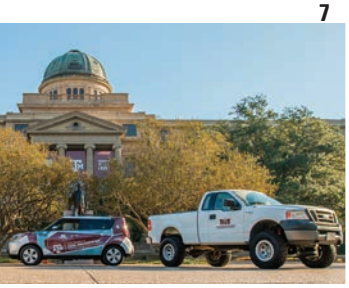

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Pulisher/Agency Director
Gregory D. Winfree

Editor
Chris Pourteau

Managing Editor
Samantha Atchison

Copy Editors
Michelle Benoit
Kelly West

Writers
Samantha Atchison
Rick Davenport
Bernie Fette
Chris Pourteau
Kelly West

Art Director
John Henry

Designers
Vicky Nelson
Stacy Schnettler

Photographer
James Lyle

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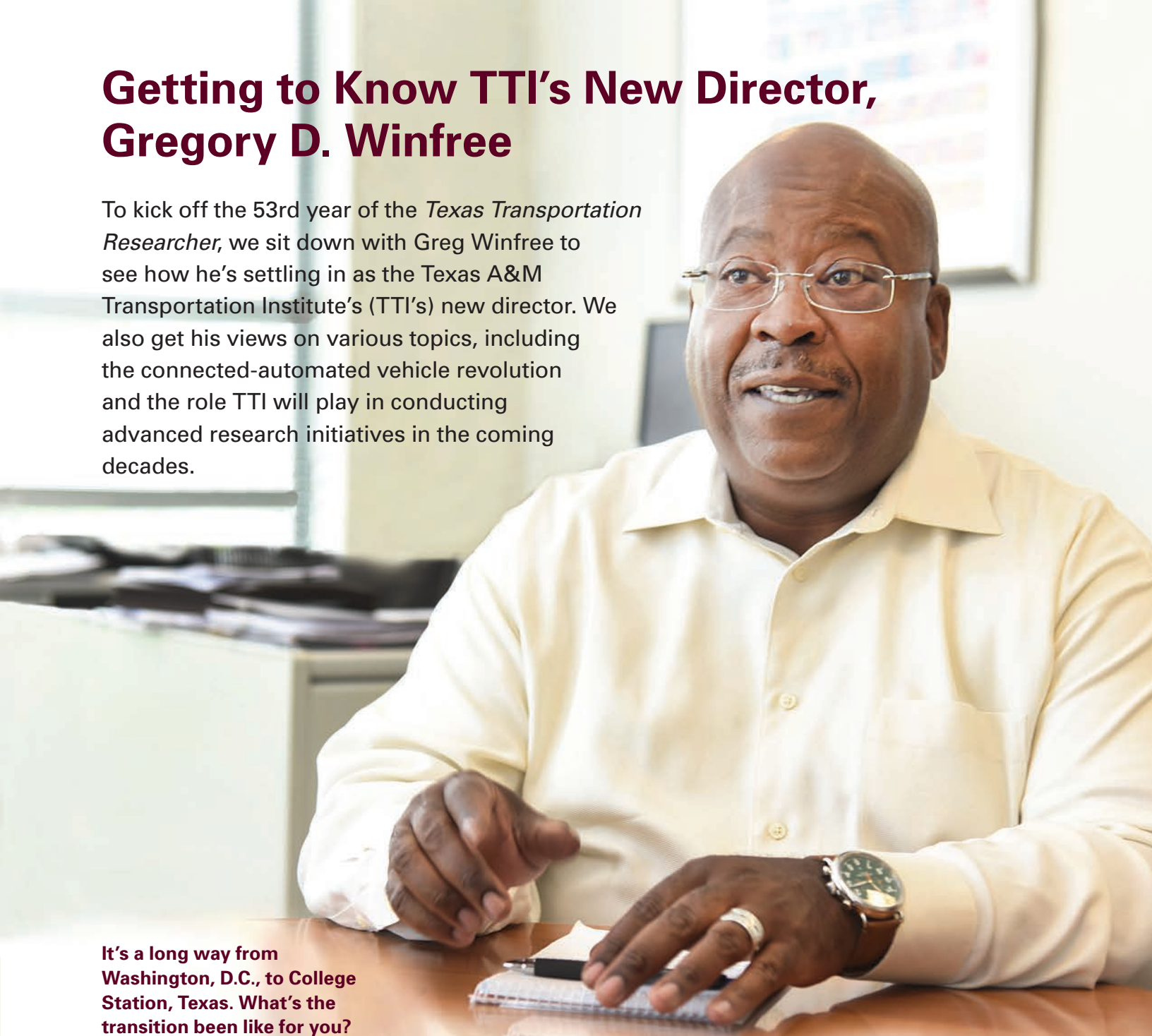
Getting to Know TTI's New Director, Gregory D. Winfree

To kick off the 53rd year of the *Texas Transportation Researcher*, we sit down with Greg Winfree to see how he's settling in as the Texas A&M Transportation Institute's (TTI's) new director. We also get his views on various topics, including the connected-automated vehicle revolution and the role TTI will play in conducting advanced research initiatives in the coming decades.



It's a long way from Washington, D.C., to College Station, Texas. What's the transition been like for you?

Earlier in my career, I made a similar move from Washington, D.C., to Danbury, Conn. Like College Station, Danbury is a mid-sized city that hosts a university community, and it's kind of nice getting out of the big city after you've been there a while. I can go into a convenience store and leave my car running, and it's still there when I come back out! And if I need a big city, I can drive two or three hours in any direction and find one. Smaller communities like this one, though, are comfortable for me.

What was your impression of TTI before applying for director? What have you learned about the Institute since becoming director that's surprised you?

I knew quite a bit about TTI, actually. When I was assistant secretary for research and technology at U.S. Department of Transportation (USDOT), I reviewed two competitions' worth of University Transportation Center grant proposals and debated the selection of finalists with the secretary and other senior DOT officials. TTI stood out even then to me, and the agency is highly respected at DOT. I also knew several of TTI's current leaders through organizations like ITS America and the Transportation Research Board.

As far as what's surprised me — TTI's Proving Grounds are well known for having improved roadside safety. But to see a crash test firsthand — that's really remarkable. The Freight Shuttle, too, is impressive on paper. But to see it in person brings home the level of effort it takes to move an idea from concept to reality. I've also learned how closely TTI works with Texas A&M Engineering, particularly the Zachry Department of Civil Engineering, to educate the next generation of transportation professionals.

"But to see it [the Autonomous Freight Shuttle System] in person brings home the level of effort it takes to move an idea from concept to reality. I've also learned how closely TTI works with Texas A&M Engineering, particularly the Zachry Department of Civil Engineering, to educate the next generation of transportation professionals."

Gregory D. Winfree, TTI Agency Director

That brings us to the theme for this issue of *Researcher* — TTI's connection with Texas A&M University and its education mission. Can you talk a little about how you see TTI's role in that relationship?

When I was at USDOT, my office was responsible for workforce development. That gave me an appreciation for a broad, multifaceted definition of that term. Certainly, Texas A&M's mission in producing well-educated graduates is vital to producing a sustainable workforce for the country. But beyond the specialists, the Ph.D.'s in engineering for example, we also have to train the folks that maintain the transportation system — the operators who turn the wrenches, who wear the steel-toed boots. TTI and its sister agencies in the A&M System are critical to that process, and we're fortunate to have access to the University's deep, broad pool of student talent. TTI offers a living laboratory that complements the classroom experience, and the students' fresh perspectives strengthen our research results. It's a win-win.

Speaking of the next generation, the connected/automated vehicle (CV/AV) revolution is coming; some would say it's already here. But there are lots of issues — from technology to policy to cybersecurity — that have yet to be addressed. Can you talk a little about how you see this revolution unfolding?

It really is already here. Assistive technologies — automated cruise control, assisted braking, lane assist — are already standard features on cars rolling off the showroom floor. We're even seeing autonomous cars being tested on public roadways. At USDOT, we didn't see it as CV/AV, with that implied divide between automated vehicles and vehicles connected to infrastructure. We thought of it more as (CAVs) — connected-automated vehicles. It's a fine point, but an important one, I think. Some private companies believe they can design autonomous cars that don't need to connect with other vehicles or the roadside, but my fundamental belief is that connectivity is critically important and should be the very first step of CAVs. About 40,000 highway fatalities a year occur in this country, and they've risen for the second straight year. CAVs can help prevent up to 80 percent of unimpaired crashes, so the safety benefits of CAVs could be significant.

TTI Agency Director Greg Winfree and TTI Senior Research Engineer Paul Carlson in an automated test vehicle.

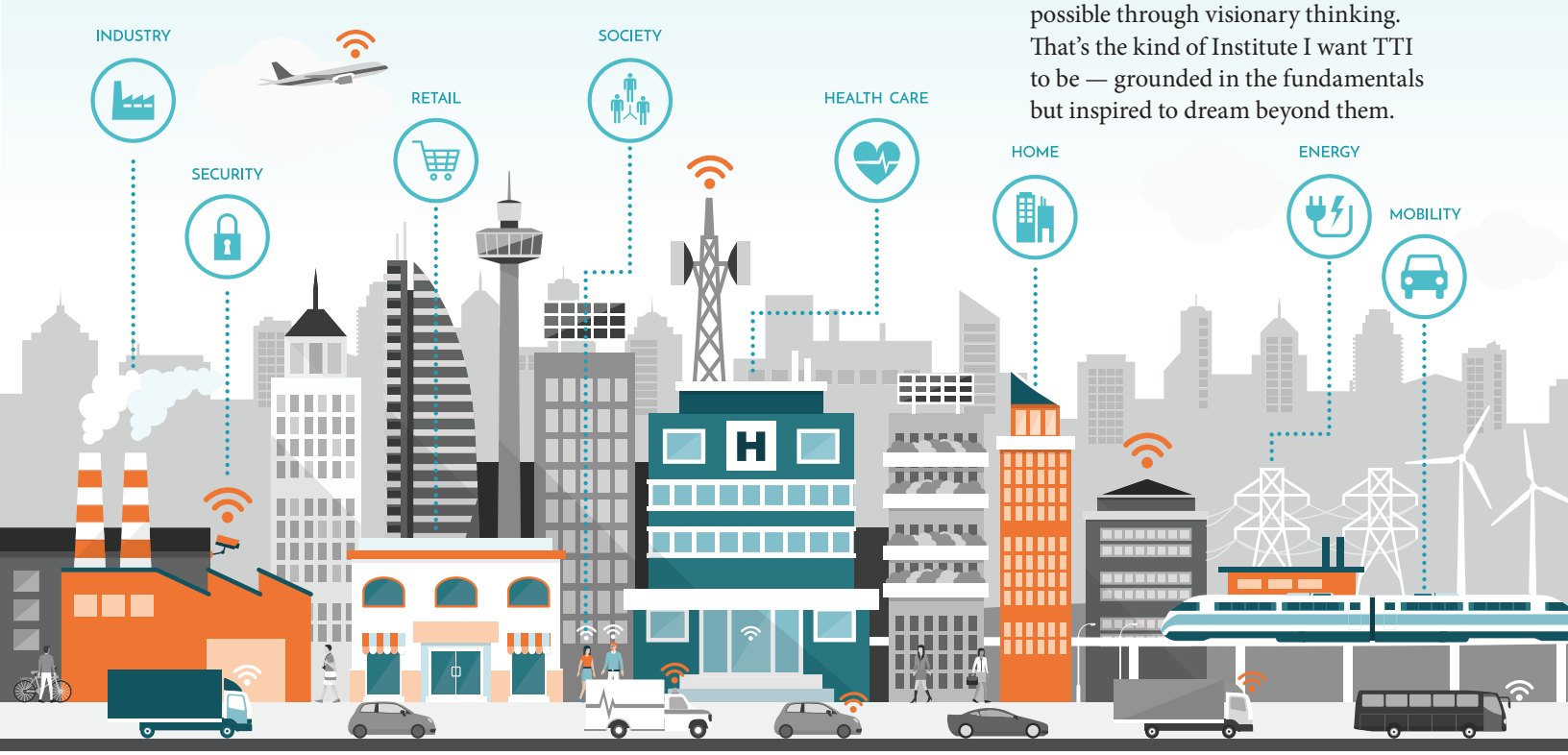
The related issues of positioning, navigation, timing and spectrum management are important to how things are changing. These vehicles communicate via DSRC [dedicated short-range communication] signals at a frequency of 5.9 GHz. The Federal Communications Commission allocated 75 MHz of spectrum in that band for intelligent transportation systems (ITS). But some Wi-Fi companies, for example, are lobbying for access to that part of the spectrum to stream faster content. It's very important to protect that neighborhood from a noisy neighbor moving in because the safety messages are transmitted 10 times per second, and any interference can dramatically impact the effectiveness of the communications. If DSRC signals are drowned out by a movie transmitted near them in the frequency spectrum, crashes can occur. Lives can be lost. We had a saying at USDOT to help remind us how important this issue is: "We don't want people getting entertained to death."

CAV technology is also reliant upon GPS for positioning, navigation and, importantly, timing. This issue of timing, however — of discrete parts of the information system handshaking in a coordinated fashion — affects more than transportation. It affects the power grid, precision agriculture, shipping, banking transfers. In transportation's case, we have to protect that quiet neighborhood to ensure public safety and a robust economy, which depends on reliably moving goods to market.

As this revolution progresses, where do you see TTI in 5 or 10 years? Will the Institute's mission evolve at all?

TTI — especially through centers like the Transportation Policy Research Center (PRC) — can play a vital part as CAVs are developed. Lawmakers need reliable transportation research — dispassionate, non-partisan facts — to generate good policies that protect the public. There's no other example I know of in the country like the PRC, which is charged by the Texas Legislature to provide reliable research findings in terms the public can understand. It's that kind of guidance — as well as TTI's more traditionally recognized expertise in ITS, maintenance and roadside safety — that the Institute can continue to provide going forward.

Someone in Washington described the concept that everything is connected as "The Internet of Things." I think the traditional engineering disciplines will morph and merge in coming decades as technology becomes more integrated and the need for mobility in Smart Cities continues to evolve. We're all waiting for the Jetsons' flying cars, right? That might sound like science fiction, but the best Sci-Fi takes the science of its time and extends what's possible through visionary thinking. That's the kind of Institute I want TTI to be — grounded in the fundamentals but inspired to dream beyond them.



What are the strengths you see yourself bringing to TTI's directorship?

I'm a lawyer by training, but I have a proficiency in technology and innovation. So, I know enough to know that I should help the Institute's experts excel in their chosen fields, not do their thinking for them. I like to think of myself as TTI's advocate, the Salesperson in Chief — it's my job to create opportunities and clear obstacles so TTI folks can do their jobs better.

As far as my leadership style goes, I've had positive and negative experiences with managers in my own career, and I've developed my style in part as a response to my own experiences with bad managers. It's always better to be respected than feared. Fear stifles creativity; it can keep employees from offering their best because they're afraid of showing up the boss. I want people to feel comfortable enough to take chances, to innovate in their fields. I want them to embrace the notion that, as long as you learn from mistakes, there's no such thing as failure.

"TTI offers a living laboratory that complements the classroom experience, and the students' fresh perspectives strengthen our research results. It's a win-win."

Gregory D. Winfree, TTI Agency Director

What's the one thing you want people to know about you as the new agency director?

I've got your back. If you're a TTI employee, part of my job — a big part of my job — is to inspire you to want to come to work every day. If you're a sponsor of TTI research, I'll work to make the Institute responsive to your needs. If you're a Texan wanting a safer transportation system, I'll encourage TTI's researchers to think outside the box — to challenge conventional wisdom and come up with innovative solutions that work in the real world. When you think about it, everyone's a stakeholder in TTI. And I've got your back. ■

TTI–Texas A&M Engineering Collaborations Enhance Educational Opportunities

A transportation revolution is about to take place, the likes of which we've not seen since the invention of the internal combustion engine.

Connected and automated vehicles (CV/AVs) hold the promise of vastly improving safety, mobility and the economy. We're on the cusp of this transformation, and The Texas A&M University System's engineering community is preparing to lead us into the future. Texas A&M Transportation Institute (TTI) researchers are working with faculty and other researchers from Texas A&M, A&M System agencies and other universities, as well as with experts from government agencies and the private sector, on the next generation of transportation research and the education of tomorrow's transportation professionals.

A&M System Chancellor John Sharp laid the groundwork for making the university a technological leader with his vision for the RELLIS Campus — a 2,000-acre, multifaceted, multimillion-dollar community with a major focus on transportation research. TTI's new headquarters building will be located at RELLIS as well.

"Over a year ago, TTI made CV/AVs a priority, but we can't be successful alone. There has to be collaboration," explains Christopher Poe, TTI's connected and automated transportation strategy lead. "This emphasis is bringing all engineering groups together, and it's already impacting our students as they are introduced to this transportation technology revolution."

"There will be a period of time, perhaps for a couple of decades, when the roads will be shared by connected, autonomous and regular cars. This intermingling of our self-driving cars and human-driven cars creates various safety challenges. How do they safely coexist? That's one of the projects we want to work on at the lab."

Dr. Swaminathan Golpalswamy
Professor, Texas A&M Mechanical Engineering Department

Some of TTI's collaborative research projects in CV/AVs involve studying:

- truck platooning with Texas A&M's Mechanical Engineering Department;
- driver workload in automated vehicles with faculty from the Texas A&M Health Science Center;
- pavement markings, signing and modeling with faculty from Texas A&M's Department of Civil Engineering; and
- the use of unmanned aerial vehicles (UAVs) to inspect roadway infrastructure with faculty from Texas A&M's Aerospace Engineering Department.

The Center for Infrastructure Renewal (CIR) is also under construction and scheduled for completion in early 2018. The $73 million, 138,000-square-foot, three-story building will house state-of-the-art infrastructure research

A first-of-its-kind two-truck platooning technology was demonstrated at The Texas A&M University System RELLIS Campus on July 22, 2016. A second demonstration will occur on May 5, 2017, as part of the Second Annual Texas A&M Transportation Technology Conference.

Artist rendering of the new Center for Infrastructure Renewal building on the RELLIS Campus. It's a collaboration among the Texas A&M Transportation Institute, the Texas A&M Engineering Experiment Station and the private sector.

In a collaborative effort across the University, researchers from multiple agencies within the A&M System are working together to develop the next generation of driverless vehicles. Photo credit: TEES Communications.

facilities and provide advanced training and education of students, technicians, engineers and future leaders in infrastructure-engineering-related areas. TTI and the Texas A&M Engineering Experiment Station (TEES) will conduct research at the center with a focus on creating longer-lasting materials for pavement and bridges, according to Bjorn Birgisson of the CIR.

"There are clear alliances with CIR and other RELLIS facilities that bring together hundreds of researchers across the campus involved in connected technologies, smart pavements and safety improvement projects," says Birgisson. "The knowledge transfer from these various RELLIS projects will create a synergy like we've never seen before."

Plans are also under way for an automation technologies lab, where research will concentrate on UAVs (drones), robotics and cybersecurity.

At both facilities, there will be a large cohort of engineering graduate students with access to the latest learning tools, including visualization labs and three-dimensional, computer-aided, virtual environments.

"There will be a period of time, perhaps for a couple of decades, when the roads will be shared by connected, autonomous and regular cars," says Dr. Swaminathan Golpalswamy of Texas A&M's Mechanical Engineering Department. "This intermingling of our self-driving cars and human-driven cars creates various safety challenges. How do they safely coexist? That's one of the projects we want to work on at the lab."

As the RELLIS Campus develops, collaborations continue to evolve. The Second Texas A&M Connected and Autonomous Vehicle Symposium for university research engineers was conducted on March 3. And on May 4–5, TTI will conduct its Second Annual Texas A&M Transportation Technology Conference specifically designed for executives of private companies and public agencies engaged in innovating, testing and deploying advanced transportation technologies.

"The future of transportation is exciting," says Poe. "And we're lucky here at TTI to have access to so much talent under the A&M System umbrella and to work with such innovative private- and public-sector research partners." ■

For more information, contact **Chris Poe** at (972) 994-2206 or c-poe@tti.tamu.edu.

A Team Effort:

Toyota Project Brings Together Multiple Institutions to Create Crash Countermeasures

In 2013, Robert Wunderlich, director of the Texas A&M Transportation Institute's (TTI's) Center for Transportation Safety gathered a team of researchers to work on a project funded by the Toyota Economic Loss Settlement — money set aside for transportation safety research. The project's goal was to find methods to reduce crashes caused by vehicle- and/or driver-based errors.

Researchers Measured

thermal body temperatures | perspiration rates | heart rates

"The overall concept of the project was to see if we could use the technological power of computers in the car to monitor vehicle and driver performance," explains Wunderlich.

To be successful, he knew, the three-year project would require a team of experts in technology, physiology, and modeling human and vehicle behaviors. The complex nature of the project required a search for experts outside TTI.

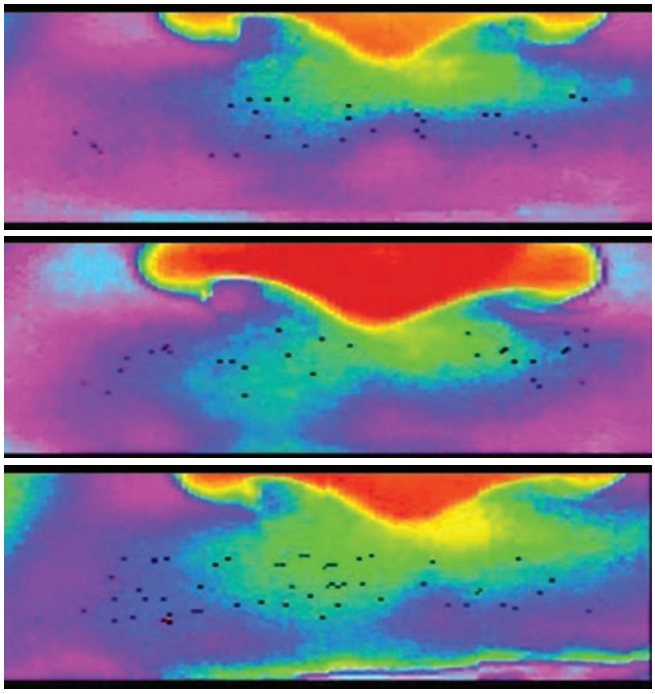
"TTI has extensive capabilities in this area, but we needed to find other specialists because the project crossed over so many different domains," says TTI Human Factors Program Manager Mike Manser. "The researchers involved were all experts in their own fields, and that's what made this project so successful."

The multidisciplinary, multi-institute team Wunderlich assembled combined TTI's infrastructure and traffic control expertise with the University of Michigan Transportation Research Institute's (UMTRI's) knowledge of vehicle operations and safety, Texas A&M University's vehicle dynamics modeling and human factors expertise, and the University of Houston's (UH's) Computation Physiology Lab.

Along with Wunderlich and Manser from TTI, the team included:

- Reza Langari, head of the Texas A&M Department of Technology and Industrial Design;
- Tom Ferris, assistant professor in the Texas A&M Department of Environmental and Occupational Health;
- Ioannis Pavlidis, director of the UH Computational Physiology Laboratory and Eckhard Pfeiffer Professor of Computer Science; and
- Shan Bao, UMTRI associate research scientist.

"This project would not be possible without collaboration because it was an A to Z operation," says Pavlidis. "Every link in this chain depended on the previous one, and each



Researchers measured changing perspiration from body temperature using thermal imaging. Above, the driver's increasing perspiration, as a result of increased stress, is reflected in the relative temperature changes of his upper lip. The more he was stressed, the more he perspired and the cooler his upper lip became (reflected in the blue-green imaging in the bottom frame).

link was done by different university teams — if one failed, the project would never make it to a successful conclusion. Team science at its best!"

Detecting Driver Stress

To detect driver stress, researchers measured the heart rates, thermal body temperatures and perspiration rates of 68 volunteer drivers. The volunteers drove the same driver simulation course in four different scenarios — under normal conditions, while distracted with cognitively challenging questions, while distracted with emotionally charged questions, and while preoccupied with texting.

The driver simulation course was conducted at TTI, and data were then sent to Pavlidis at UH for analysis.

"The beautiful thing about data nowadays is that we can run the simulations in College Station and send them to Houston to be analyzed without any added travel costs," Manser observes. "That speaks to the new way we do research these days — these collaborations can be done remotely and still be quite successful."

Similar tests were also conducted using production vehicles on the RELLIS test track. The detection system was also tested on public roads in the College Station area.

"TTI has extensive capabilities in this area, but we needed to find other specialists because the project crossed over so many different domains. The researchers involved were all experts in their own fields, and that's what made this project so successful."

Mike Manser
TTI Human Factors Program Manager

Detecting Vehicle Error

Langari and his team at Texas A&M worked with the UMTRI team, led by Bao, and developed algorithms to determine vehicle-based errors or anomalies that might occur while driving — particularly unintended acceleration.

The UMTRI team analyzed naturalistic driving data, accumulated from a prior National Highway Traffic Safety Administration–supported study, for normal patterns of behavior so they could distinguish any abnormal behavior that would fall outside that range. The Texas A&M team produced their own human-subject data using a driving simulator to determine normal and abnormal driving and developed their own specific techniques for this purpose.

"Toward the end of the project, we jointly developed some test scenarios that were evaluated at Texas A&M in our driving simulator, and the data were shared with UMTRI," explains Langari. "Both their methods and ours were applied to that same dataset to ensure we had alternative approaches to deal with this relatively complex problem."

After three years of data collection and analysis, the team developed a countermeasure to detect vehicle-based malfunctions and driver-based errors.

"We were able to identify real-world problems — vehicle errors and high levels of driver stress — and conduct a series of projects to create a product that can be implemented immediately by vehicle manufacturers to improve safety," explains Manser. "And it all came about through these series of experiments that started out with this very theoretical concept about what we could do." ■

For more information, contact **Robert Wunderlich** at (979) 845-2095 or r-wunderlich@tti.tamu.edu, or **Mike Manser** at (512) 407-1172 or m-manser@tti.tamu.edu.

Learning by Doing: TTI Provides Texas A&M Students Hands-On Experience

Texas A&M University students have been involved in the research process at the Texas A&M Transportation Institute (TTI) since the Institute's founding in 1950. Currently, TTI employs 216 students — 75 of which are graduate research assistants. TTI's Materials and Pavements Division alone employs 61 graduate and undergraduate assistant researchers. As they were 67 years ago, students are still an integral part of the work done at TTI.

"Graduate research assistants are crucial to the success of the Materials and Pavements Division since they are often responsible, under the supervision of their advisors and principal investigators, for testing, data analysis, and the initial preparation of reports and papers," says David Newcomb, division head. "Likewise, research assistants also benefit from hands-on lab and field work, mathematical modeling, and the experience of writing technical reports. This is how I began my career at TTI, and it was a great start."

Fawaz Kaseer, Ph.D. Student
Zachry Department of Civil Engineering

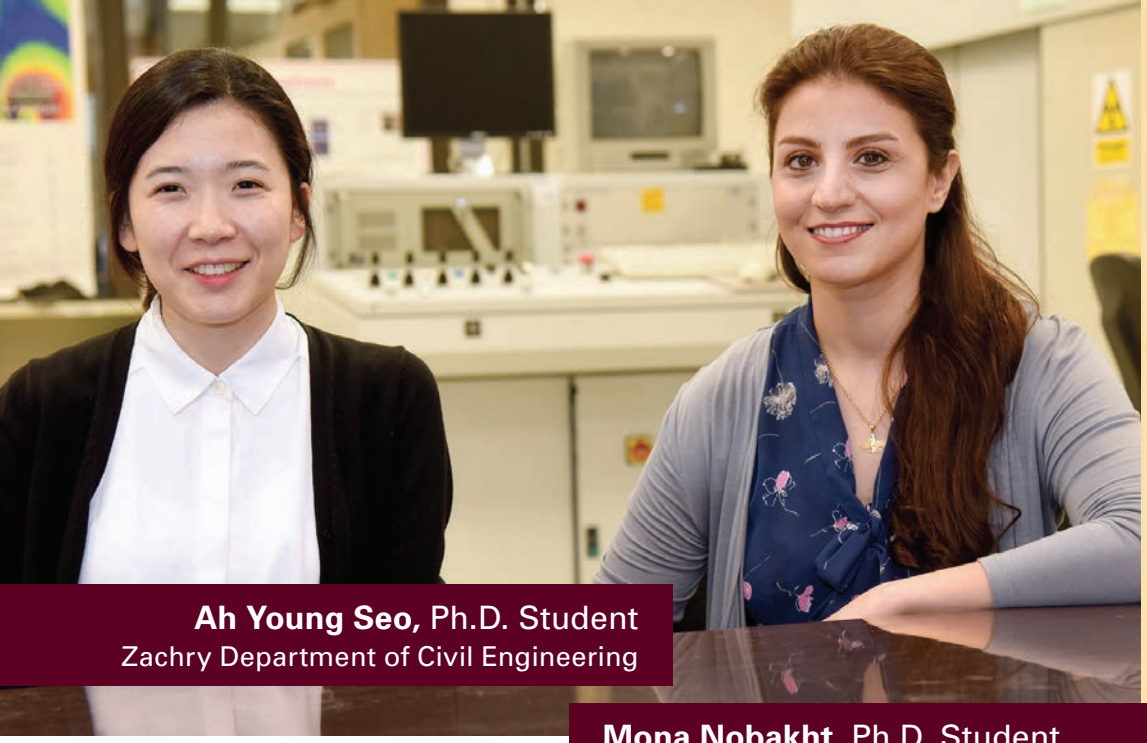
"Working at TTI has allowed me to learn more about the career path I'm pursuing, and helped me to set the foundation for my career in the future," explains Fawaz Kaseer, a graduate assistant in TTI's Pavement and Materials Division.

Kaseer has worked on National Cooperative Highway Research Program Project 9-58: The Effects of Recycling Agents on Asphalt Mixtures with High RAS and RAP Binder Ratios. Kaseer's contributions included performing a literature review, testing binders and mixtures, analyzing lab data toward using more recycled materials, writing reports and research papers, and presenting findings at various conferences.

"Fawaz is an intelligent, responsible and motivated graduate student researcher who develops solutions to problems that arise during the course of experimental research," says TTI Research Engineer Amy Epps Martin. "He's also an excellent team player who works well with others to develop implementable research products." ■

"Working at TTI has allowed me to learn more about the career path I'm pursuing, and helped me to set the foundation for my career in the future."

Fawaz Kaseer
Texas A&M University Ph.D. Student in Civil Engineering



Ah Young Seo, Ph.D. Student
Zachry Department of Civil Engineering

Mona Nobakht, Ph.D. Student
Zachry Department of Civil Engineering

"Collaborating with highly experienced TTI researchers gives me a broader perspective on research development. I believe being part of TTI is a bold item in my resume, which could help me achieve my career goals."

Mona Nobakht
Texas A&M University Ph.D. Student in Civil Engineering

Ah Young Seo, graduate assistant in TTI's Materials and Pavements Division, worked on the Texas Department of Transportation (TxDOT) project Performance Evaluation, Specifications, and Implementation of Trackless Tack.

Seo conducted a literature review, characterized trackless tacks available in Texas, tested and analyzed methods to evaluate the tracking resistance and bond strength of trackless tack, and documented test procedures and findings with research team members.

"Working at TTI has added to my research experience and focused my interests. It's allowed me to get familiar with various experimenting techniques and devices," says Seo. "The TxDOT project provided me with an opportunity to work in the field and eventually offered a new idea to develop for my dissertation."

Seo has also garnered international recognition for her work. In 2015, she was selected for the Road Scholar Program provided by the International Road Federation based on her academic credentials and leadership potential. Award recipients are required to attend a professional curriculum in Washington, D.C., during the Transportation Research Board (TRB) Annual Meeting. ■

"Working at TTI has added to my research experience and focused my interests. It's allowed me to get familiar with various experimenting techniques and devices."

Ah Young Seo
Texas A&M University Ph.D. Student in Civil Engineering

For the past two years, Mona Nobakht has assisted TTI researchers on the Oklahoma Department of Transportation–funded project Selection of Long-Lasting Rehabilitation Treatment Using Life Cycle Cost Analysis and Present Serviceability Rating.

Nobakht developed an innovative, performance-based methodology for selecting long-lasting and cost-effective rehabilitation treatments for Oklahoma roadways. Three papers were published from the results of the study in various industry journals, and the results were also presented at several conferences, including the TRB Annual Meeting.

"Collaborating with highly experienced TTI researchers gives me a broader perspective on research development," says Nobakht. "I believe being part of TTI is a bold item in my resume, which could help me achieve my career goals."

Nobakht was the 2017 recipient of the Dr. David R. Jones IV scholarship, awarded annually by the Association of Modified Asphalt Producers. Out of 64 applicants, three award recipients were recognized based on their activities in asphalt technology, work experience relative to the highway industry, and school activities.

TTI Assistant Research Engineer Maryam Sakhaeifar says, "I have found Ah Young and Mona to be intelligent engineers of the highest character, socially confident and hard working — natural leaders." ■

For more information, contact **David Newcomb** at (979) 458-2301 or d-newcomb@tti.tamu.edu.

Student Insights Lead to Research Innovations

TTI Provides Guidelines for Ports Seeking TRZ Financing

IN 2007, THE TEXAS LEGISLATURE ENABLED A NEW FINANCING MECHANISM, the transportation reinvestment zone (TRZ), to encourage local infrastructure development. TRZs have proven very successful over the last decade for highway development.

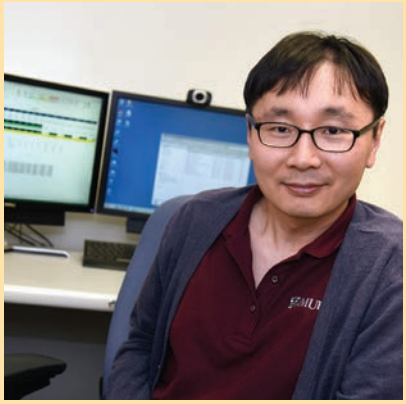
TRZs designate an *impact area* around a needed improvement project. A municipality or county can use some or all of the property and sales tax increment revenue projected to accrue from the improvement to fund the project. While the original legislation applied to most transportation projects, port projects weren't included — until now.

"The funding tools available to Texas ports have traditionally been focused on improvements within the ports themselves," explains Texas A&M Transportation Institute (TTI) Senior Research Scientist Rafael Aldrete, who heads TTI's Center for International Intelligent Transportation Research. "The legislation in 2013 recognized the positive impact expanding ports can have on the broader local landscape."

Once the legal framework was in place, port authorities and the Texas Department of Transportation (TxDOT) saw the need for guidelines ports could use to set a TRZ. Under TxDOT's direction, TTI developed webinar materials, case studies and evaluation tools, which are now available for any port to use.

"The quality of the roads — both within and outside the port — can impact a port's effectiveness, and that in turn impacts the local economy," says Aldrete. As ports expand by, say, increasing warehouse capacity, they naturally employ more local residents to work in those warehouses. And the residents need places to live (helping create a healthy real estate market) and buy goods (improving the local gross domestic product). In short, a healthy port makes for a healthy community.

Deog Bae, a Texas A&M University Ph.D. student in civil engineering, played a key role in Aldrete's research team. Bae helped generate a methodology that yields a reasonable expectation for what a port project can produce in expected tax increment revenues over the life of the TRZ; and that, in turn, helps a port authority scope the local TRZ.



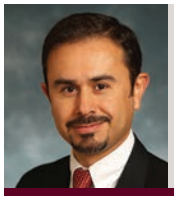
"We used the ports in Beaumont and Brownsville to refine our model and now it's applicable to any port, anywhere, seeking funding through a TRZ."

Deog Bae
Texas A&M University Ph.D. Student in Civil Engineering

"We used the ports in Beaumont and Brownsville to refine our model," explains Bae, "and now it's applicable to any port, anywhere, seeking funding through a TRZ."

Texas has often led the nation in advancing transportation, and it was the first state to implement TRZs. Now, once again, TxDOT is setting the standard for ports nationwide to take advantage of this innovative financing tool. ■

Thanks to TTI, new guidelines will soon be available for Texas ports looking to finance expanded operations with financing from transportation reinvestment zones.



For more information, contact **Rafael Aldrete** at (915) 521-8101 or r-aldrete@tti.tamu.edu.

Updated every 30 minutes, the website created by TTI can help shippers better estimate how long it takes to move goods across the U.S.-Mexico border.

Jose Rivera Montes De Oca, a Texas A&M University graduate student studying math.

TTI Provides More Reliable Cross-Border Travel Time Estimates

FOR SHIPPERS, KNOWING HOW LONG IT TAKES TO MOVE FREIGHT IS IMPORTANT TO THEIR BOTTOM LINE. But until now, accurately predicting the time it takes to cross the border hasn't been possible.

Though careful vetting of shipments crossing the border is necessary to maintain security, unreliable border wait times can cause major slowdowns for freight traveling from Mexico to the United States. In 2008, the Texas A&M Transportation Institute (TTI) demonstrated a system to the Federal Highway Administration that accurately, reliably leveraged technology to collect border wait time data.

Over the course of several research projects, TTI researchers created a solution that uses radio-frequency identification (RFID) technology, currently present in most trucks, to measure border wait times. Deployed at seven commercial ports of entry across Texas, this system provides anyone interested — and especially U.S. Customs and Border Protection — with reliable estimates via the website TTI created.

Before the website was available, shippers relied on the free travel-time estimates provided by Google to predict cross-border travel times, but the time spent at the crossing was not included in Google's estimate. TTI's approach uses the border wait times from the website combined with travel times from Google to provide a better travel-time prediction.

"We're supplying that missing piece of the puzzle," says TTI Software Developer Swapnil Samant. "With the machine-learning algorithm we developed, we can predict accurate travel times from origin to destination and post them to the website for a given 24-hour period. And we refine the estimate every half hour."

By updating the estimate 48 times a day, TTI can provide shippers with an accurate travel-time estimate for commercial vehicles passing through border checkpoints. And it wouldn't have been possible, Samant says, without the expertise of Jose Rivera Montes De Oca, a Texas A&M University graduate student studying math.

Beginning with data generated in 2013, the algorithm takes reams of historical data and predicts the expected wait time at the border for a given day and time. That means more efficient cross-border supply chains, and that can mean a better bottom line for U.S. manufacturers and, potentially, savings for consumers.

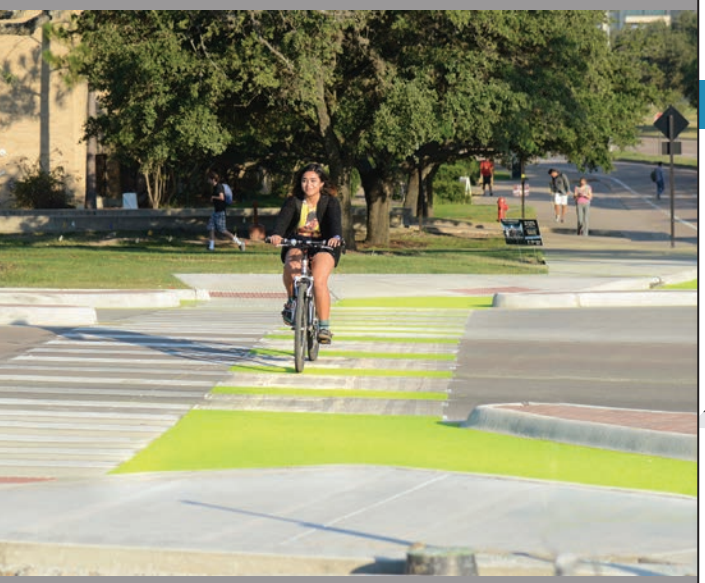
"Sometimes the field of mathematics is so theoretical, you can't really explain what you do to other people," says Rivera Montes De Oca. "But I can point to the website and show them how my work makes a difference. My time at TTI has been amazing. If I could work here the rest of my life, I would." ■

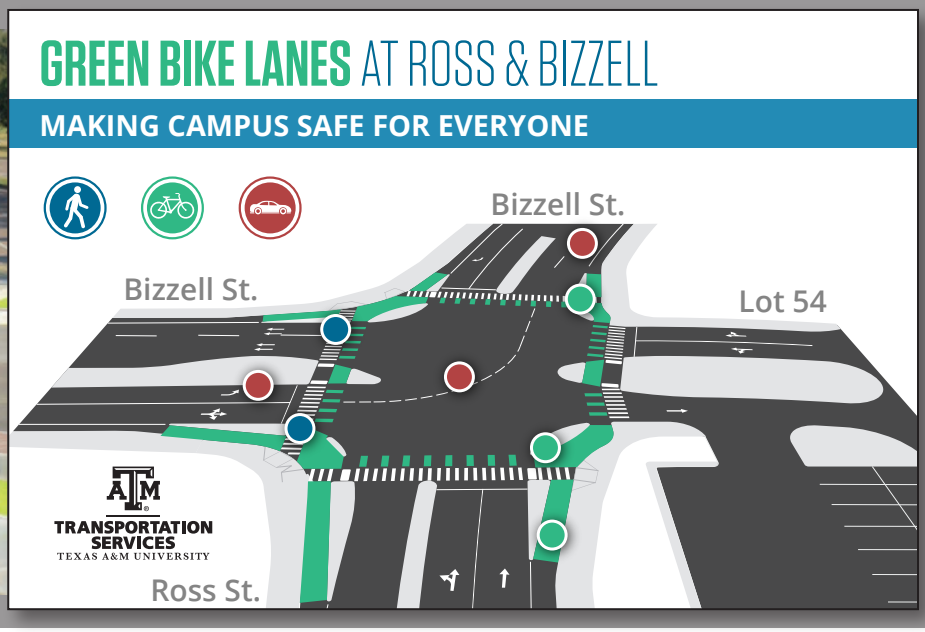
"We're supplying that missing piece of the puzzle. With the machine-learning algorithm we developed, we can predict accurate travel times from origin to destination and post them to the website for a given 24-hour period. And we refine the estimate every half hour."

Swapnil Samant
TTI Software Applications Developer

For more information, contact **Swapnil Samant** at (915) 521-8105 or s-samant@tti.tamu.edu.

Texas A&M, TTI, TEES Partner in Campus Transportation Technology Initiative





The recently completed Dutch-style unsignalized intersection at Texas A&M University with solar luminescent green paint bicycle pathways. A bicyclist rides over the newly installed solar bicycle pathway at Ross and Bizzell Streets on campus.

"This initiative provides hands-on opportunities for our students to implement real-world transportation innovations. From assessing a unique solar luminescent bicycle pathway to analyzing various intersection enhancements, the learning opportunities for our students are exceptional."

M. Katherine Banks
Vice Chancellor and Dean of Texas A&M Engineering

The Texas A&M Transportation Institute (TTI) and the Texas A&M Engineering Experiment Station (TEES) are partnering under a contract with Texas A&M University to develop a smarter campus transportation ecosystem. Texas A&M University President Michael K. Young created the Campus Transportation Technology Initiative (CTTI) to bring private-sector transportation innovation into the real-world environment of a university campus to improve safety, mobility and quality of life.

"An early implementation and a big change on campus is at the intersection of Ross and Bizzell Streets that deployed innovative bicycle lane pavement markings that glow at night for cyclists," says Bob Brydia, TTI's senior research scientist leading the CTTI project. "The markings absorb solar power during the day and emit a soft glow to illuminate the bike paths within the intersection at night."

The initiative's goal is to encourage those with technologies that may improve a transportation environment to bring them to Texas A&M's campus, where administrators and planners are looking to demonstrate and evaluate ideas. Using multiple, similar technologies in the same location can also show how synergies can be developed between technologies and modes. Texas A&M University Transportation Services, led by Associate Vice President Peter W. Lange, is TTI's partner on the university side.

"We think we will see companies that will develop mobile apps and other innovative concepts that can help make alternative transportation options more seamless to commuters," says Lange.

How It Works

An initial request for information, issued in June 2016 by TTI and TEES, generated responses from more than 30 companies, ranging from multinationals to entrepreneurs. The call is open through August 2017, and implementations and evaluations are currently scheduled through December 2017. Once a demonstration is in place on campus, TTI and its partners determine how well the technologies work, either independently or in combination, to address transportation issues in the campus environment.

Implementations currently taking place or being planned at Texas A&M include:

- solar luminescent bicycle pavement markings (a first in the United States) applied at the nation's first unsignalized Dutch junction intersection;
- the first transit-fleet data collection in the country to support the improvement of Environmental Protection Agency emissions modeling;
- automated parking lot analytics using camera images and cloud-based processing;
- next-generation traffic-data-collection equipment;
- WiFi-based triangulation of transit fleet customers to examine bus-stop efficiencies and placements; and
- paper-based assessment of potential future modes of mass transport.

Workers apply bright green solar luminescent pavement markings to the bicycle pathways on the Texas A&M University campus.

Academic Benefits

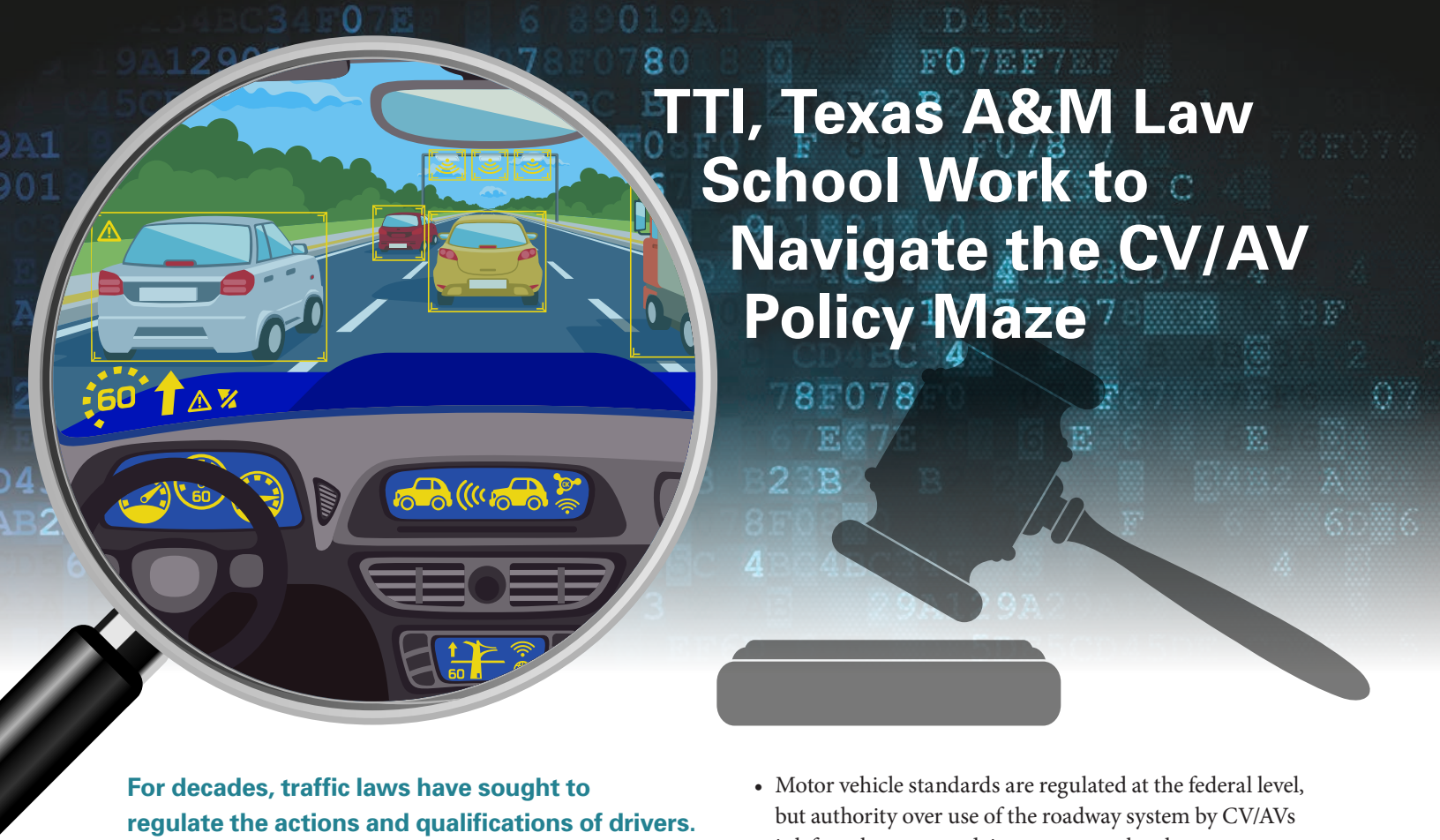
Academic partnerships are a key desired outcome of the initiative. The expansive environment of the Texas A&M campus — a mega-campus that provides access to large numbers of students while maintaining Texas A&M's reputation as a high-end research university — provides a valuable, real-world laboratory in which Texas A&M students can help researchers test advanced technologies outside the classroom. Significant progress has been made to bring the evaluation of the projects into the classroom over the past semester, with Texas A&M colleges already involving students in the engineering, planning and policy aspects of the various technology deployments. With more than 15,000 students currently in the Texas A&M College of Engineering — and a goal of growing that number to 25,000 by 2025 — the university itself is augmenting the classroom experience for future transportation engineers currently studying at Texas A&M.

"This initiative provides hands-on opportunities for our students to implement real-world transportation innovations," says M. Katherine Banks, vice chancellor and dean of Texas A&M Engineering. "From assessing a unique solar luminescent bicycle pathway to analyzing various intersection enhancements, the learning opportunities for our students are exceptional."

Examples of projects students might be involved in include:

- qualitative assessment of bicycle markings;
- prototyping of the quantitative assessment of intersection movements via recorded video to examine behavior by modes (e.g., vehicles, pedestrians and bicycles);
- analysis of transit fleet data matching loadings to engine performance and emissions;
- comprehensive assessment of intersection function with new markings;
- development of a transit-demand prediction tool for new areas of demand, such as new student housing areas; and
- development of a trip-planning website combining multiple modes of travel and links between modes for the campus community. ■

For more information, contact **Robert E. Brydia** at (979) 845-8140 or r-brydia@tti.tamu.edu.



TTI, Texas A&M Law School Work to Navigate the CV/AV Policy Maze

For decades, traffic laws have sought to regulate the actions and qualifications of drivers. But what if the driver isn't a human being?

If the car drives itself, what does that mean for driver-education courses? If the self-driving car is involved in a crash, who's at fault? And if the operator of the self-driving car has no driving responsibilities, can he or she be impaired without fear of liability?

And while we're at it, just how do we define *operator*?

"We have all these laws on the books, and we have emerging disruptive technologies that create ambiguities with those laws," says Ginger Goodin, director of the Texas A&M Transportation Institute's (TTI's) Transportation Policy Research Center. "We have to find a way to harmonize the two."

That need for harmony is central to an expanding collaboration between TTI and the Texas A&M University School of Law. Experts from each institution are exploring the numerous legal issues found at the crossroads of transportation and technology, among them the following:

- Connected and automated vehicles (CV/AVs), to operate efficiently, require huge amounts of locational and personal data. The collection and use of those data raise privacy concerns, in addition to questions over who owns the data and how they can be used.
- CV/AVs also require robust wireless communications networks. These could potentially be exposed to hacking and/or cyberterrorism, creating far-reaching implications for national security.
- Motor vehicle standards are regulated at the federal level, but authority over use of the roadway system by CV/AVs is left to the states and, in some cases, local governments. This opens the possibility for a regulatory patchwork that breeds uncertainty for everyone concerned.

"There's a rapidly growing industry developing and implementing the technologies that promise to reshape transportation, and a well-established community of policy makers who are responsible for regulating that transportation," says TTI Agency Director Greg Winfree. "It is essential that we also have a research community well studied and comfortable in both of those worlds. That's why TTI's growing relationship with the Texas A&M Law School is so vitally important."

Joint research efforts thus far have focused on the policy implications of unmanned aircraft systems, truck platooning and transportation network companies. TTI also played a central part in a Texas A&M Law School symposium last year focusing on transportation and technology.

"CV/AVs will have the greatest influence on mobility since the birth of the Interstate Highway System, but we're going to face a lot of complexities along the way," says Texas A&M Law School Dean Andy Morriss. "In working with TTI, we can navigate those issues and help the nation fully realize the potential benefits of autonomous travel." ■

For more information, contact **Ginger Goodin** at (512) 407-1114 or g-goodin@tti.tamu.edu.

TTI Employees Honored with TRB Best Paper, Student of the Year Awards

Five Texas A&M Transportation Institute (TTI) researchers were presented with best paper awards during the Transportation Research Board (TRB) 96th Annual Meeting, held in Washington, D.C., Jan. 8–12. One of the researchers also received an Outstanding Student of the Year Award at the Council of University Transportation Centers banquet held prior to the TRB Annual Meeting.

Traffic Operations and Roadway Safety Division Head Paul Carlson and Professor in Civil Engineering and TTI Research Engineer Gene Hawkins co-authored a paper that received the 2017 Cunard Award, given to the best paper in the Operations Section in which the primary author was under the age of 35. The primary author in this case was Brad Brimley, a former TTI researcher and civil engineering Ph.D. student. The paper, "Guidelines for Traffic Control Devices at Changes in Horizontal Alignment," was also chosen 2016's best paper in the TRB Traffic Control Devices Committee. The innovative National Cooperative Highway Research Program (NCHRP) research project included a field study that tested drivers on unfamiliar roadways.

Marcus Brewer accepts the ATLAS Center Student of the Year award from Caesar Singh, director of university grants programs at the U.S. Department of Transportation.

Sue Chrysler (middle) and Jonathan Dobres of MIT (left) receive a TRB best paper award from TRB Traffic Control Device Committee Co-chair Tim Gates (right).

Senior Research Scientist Sue Chrysler worked with colleagues from the Massachusetts Institute of Technology (MIT) on a project that evaluated font styles for use on highway signs. Chrysler co-authored the paper, "Empirical Assessment of Legibility of Highway Gothic and Clearview Signage Fonts." It received the 2017 best paper award from the Traffic Control Devices Committee.

The TRB Geometric Design Committee's Best Paper Award was presented to Associate Research Engineer Marcus Brewer and his TTI co-author, Research Scientist Akram Abu-Odeh. The paper, "Effects of Cross-Slope Break on Roadway Departure Recovery of Trucks on Horizontal Curves," evaluates roadside design features in an effort to reduce truck rollovers. Research on the NCHRP project was led by MRIGlobal and conducted by TTI.

Brewer, a Ph.D. candidate in civil engineering at Texas A&M University, was named the 2017 Center for Advancing Transportation Leadership and Safety (ATLAS Center) Student of the Year. A collaboration between the University of Michigan Transportation Research Institute and TTI, the ATLAS Center is a Tier 1 University Transportation Center. ■

For more information, contact **Rick Davenport** at (979) 862-3763 or r-davenport@tti.tamu.edu.

TTI Encourages Young Women to Pursue STEM Careers

On Saturday, Feb. 25, more than 6,000 girls ranging from kindergarten to eighth grade attended "Girl Day 2017" hosted by the Women in Engineering Program, part of The University of Texas at Austin's Cockrell School of Engineering. TTI Research Scientist Steven Polunsky volunteered at the event and interacted with numerous young women interested in science, technology, engineering and mathematics (STEM) careers.

"When we go to these events, we are looking to kindle that fire of curiosity in someone," explains Polunsky. "I want them to see a crash test, touch a piece of road bed, examine highway sign letters under a microscope, and think 'that's not so hard. I can do that. I can help people be safe.' I'm proud that TTI helps make the opportunity possible." ■

TxDOT, TTI Sign MOU to Test Connected and Automated Vehicle Technologies

TTI and the Texas Department of Transportation (TxDOT) recently co-signed a memorandum of understanding (MOU) spelling out the guidelines to allow TTI to test lab-proven technologies in real-world environments.

"We are rapidly moving into a new world of transportation that will include cars communicating with other cars and cars that drive themselves," TxDOT Executive Director James Bass says. "Since the transportation industry is on the leading edge of this transformation, testing is vital in real driving environments. We're excited to be part of that along with the Texas Department of Motor Vehicles and the Texas Department of Public Safety to make sure those technologies are tested in the safest possible ways."

Through this MOU, TTI can propose testing of its own technology applications or technologies from industry and other universities. TTI will develop a plan with TxDOT that details the technology to be tested, how it performed in previous laboratory and controlled tests, and where and for how long it will be tested. The plan will also describe how the tests can be safely demonstrated and piloted on Texas highways.

"Those technologies range from detection of wrong-way drivers to new pavement markings and signs that can be read by automated vehicles," says TTI Assistant Agency Director Christopher Poe, the Institute's CV/AV transportation strategy lead. "Working with TxDOT, the first real-world technology testing plans under this agreement could begin within months." ■

For more information about TTI News, contact **Rick Davenport** at (979) 862-3763 or r-davenport@tti.tamu.edu.

A&M System Board of Regents Recognizes Epps

Jon Epps, TTI executive associate director and senior research fellow, received the Regents Fellow Service Award from The Texas A&M University System Board of Regents during an awards dinner Feb. 9. Established in 1998, the Regents Fellow Service Award recognizes A&M System agency researchers who make lasting contributions to Texas and the nation.

A pioneer in asphalt-pavement recycling and soil-stabilization methodology, Epps' 45-year career in the transportation industry includes research in pavement-management systems and pavement economics. He leads TTI's Materials, Pavements and Constructed Facilities Division and the Roadside Safety and Physical Security Division, as well as oversees the Institute's research in construction engineering, highway structures, flexible pavements, roadside safety and physical security devices, structural testing, and other areas.

Left to right: Chancellor John Sharp, Board of Regents Chairman Cliff Thomas, Jon Epps and Board of Regents Vice Chairman Elaine Mendoza.

"Being named a Regents Fellow is certainly a highlight of my career," Epps says. "I've been extremely fortunate to work alongside great people, who have been vital to the overall success of these programs and efforts." ■

TTI Briefs Texas Legislators on Autonomous Vehicles, Safety Issues, Research Priorities

On Dec. 7, 2016, Ginger Goodin, director of TTI's Transportation Policy Research Center (PRC), briefed the Texas House Transportation Committee on autonomous vehicles in the context of policy and regulation. Robert Wunderlich, director of TTI's Center for Transportation Safety, provided information on significant trends in roadway safety. And on March 2, 2017, Goodin and TTI Agency Director Greg Winfree briefed members of the Texas House Committee on Transportation regarding TTI's current research priorities.

Goodin's winter testimony was drawn from published and ongoing research and researchers' observations, as well as policy guidance produced in September 2016 by the National Highway Traffic Safety Administration (NHTSA). One of NHTSA's key objectives, Goodin told the committee, is to ensure a consistent national framework for state-level regulation of highly automated vehicles for both testing and operation.

Wunderlich's testimony drew from TTI research conducted to assist in updating the Texas Strategic Highway Plan, first produced 10 years ago. In addition to satisfying federal requirements, the plan identifies key safety needs and serves as a guide for investment decisions designed to reduce the frequency of deaths and injuries on Texas roadways.

In his testimony in March, Winfree noted that TTI's research program has "continued to grow, maintaining its distinction as the largest university-based research agency of its kind in the United States," despite times of uncertain federal funding and many competing interests. Goodin highlighted the PRC's research in areas of finance, freight, congestion and transportation network companies — all of which are issues central to policy discussions in the current legislative session. ■

TTI briefs Texas legislators on March 2, 2017. Left to right: Texas House Transportation Committee Chair Geanie Morrison, Morrison's Chief of Staff MacGregor Stephenson, TTI Agency Director Greg Winfree, and TTI PRC Director Ginger Goodin.

TTI Assists in Unmanned Aerial Systems Project

TTI, along with the Lone Star UAS Center of Excellence and Innovation (LSUASC) at Texas A&M University–Corpus Christi, will provide support to a two-year project led by The University of Texas at Arlington on how unmanned aerial vehicles (UAVs) can be used to inspect highways and railroads remotely. TxDOT is sponsoring the project. LSUASC and TTI will develop procedural guidelines and best practices for the use of UAVs for this purpose.

"The use of UAVs in the United States is growing fast, and I look forward to working with the project team to see how UAVs may be best utilized to study our transportation infrastructure," says TTI Research Scientist Jeff Borowiec. ■

Texas Designated as Automated Vehicles Proving Ground

The U.S. Department of Transportation (USDOT) has designated Texas as a national Automated Vehicle (AV) Proving Ground for the testing of connected and automated vehicle technologies to solve community challenges. The Texas AV Proving Grounds Partnership includes TTI, the Texas Department of Transportation (TxDOT), The University of Texas at Austin's Center for Transportation Research, the Southwest Research Institute, and 32 municipal and regional partners.

"With five of the nation's 15 fastest-growing cities in Texas and our population expected to potentially double by the year 2050, Texas must be a leader in new technology that addresses transportation challenges," says TxDOT Deputy Executive Director Marc Williams. "This partnership puts Texas at the forefront of automated vehicle technologies that likely will shape the future of transportation around the world."

Texas offers a full and varied range of testing environments, from high-speed barrier-separated managed lanes to low-speed urban environments such as university campuses, medical districts, transit bus corridors and border crossings. Selected from an applicant pool of more than 60, the Texas AV Proving Grounds Partnership joins nine other designees in a community of practice that will be instrumental in helping USDOT provide critical insights into optimal big data usage and further develop guidelines for developing automated vehicle technologies. ■

TEXAS TRANSPORTATION
Researcher 53.1
Texas A&M Transportation Institute/TTI Communications
3135 TAMU
College Station, TX 77843-3135

Periodicals
Postage
PAID
College Station
Texas 77843

THE SECOND ANNUAL TEXAS A&M TRANSPORTATION TECHNOLOGY CONFERENCE will be held May 4–5 in Bryan, Texas. This year's conference theme is Infrastructure for Connected Automation.

The conference seeks to create national collaborations to advance the research, testing and deployment of transportation technology.

Register online by April 20 at https://tti.tamu.edu/conferences/ttc17/.

THE 2017 TRAFFIC SAFETY CONFERENCE, held June 7–9 in Las Colinas, Texas, will focus on actions we can take to implement the strategies and countermeasures of the revised Texas Strategic Highway Safety Plan.

Conference sessions topics will include impaired driving, distracted driving, intersection safety, pedestrian safety, lane and roadway departures, speeding, and older system users.

Register now at https://tti.tamu.edu/group/cts/traffic-safety-conference/2017-traffic-safety-conference/.