

Researcher

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IMPLEMENTATION

*Where the Research
Meets the Road*

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ON THE COVER: TTI research yields practical innovations dedicated to making the Texas transportation system smarter, safer and more efficient.



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TEXAS TRANSPORTATION
Researcher

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TTI Research: Making Things Better

Or, Why Transportation Research Is More Important Than Ever

It's hard to tighten your belt when you run out of holes in the leather. But when you can't afford a new belt, you just have to work with what you've got.

In a nutshell, that's what the Texas Legislature is facing in the current budget cycle. According to some estimates, Texas faces a budget shortfall in the neighborhood of \$20 billion. Legislators will have to make some tough decisions as a result.

In this environment, the benefits derived from effective, implementable research can be considerable. Through research, the Texas Transportation Institute (TTI) seeks "a better way." I've said that before in this column, but it's worth repeating in these days of stretching state dollars to meet public needs. Better is defined to mean a smarter, safer and more efficient transportation system. In legislative terms, improved traffic safety means lives saved, less injuries and an overall reduced impact from crashes on our health care system. Businesses and commuters alike see benefits from a smarter transportation system through reduced fuel consumption and air pollution and cheaper goods that reach store shelves more efficiently. All of that equates to reduced overall costs and a higher quality of life for Texans.

Beyond the benefits realized from investing in quality research, in recent years the Texas Legislature has relied on TTI more directly via testimony about the state of our transportation system and its needs. From our work with the 2030 Committee, which provides data about the transportation challenges faced by Texas in the next two decades, and studying funding alternatives, such as vehicle mileage fees, the Institute's expertise is giving

legislators the background they need to craft good policy for the citizens of Texas.

With its summary of recent TTI testimony before the Texas Legislature, the center spread of this issue of *Researcher* paints a broader portrait of how much legislators rely on what we know about transportation at TTI. And beyond the borders of Texas, we're helping sponsors, from Washington State to Florida, find that better way. TTI's *2010 Urban*

Mobility Report — currently the nation's standard for understanding the impact of congestion on bottom lines around the country — was released this quarter.

The coming year will see a new national standard for sign retroreflectivity, and the nation's roads will be a little bit safer thanks to work by TTI staff.

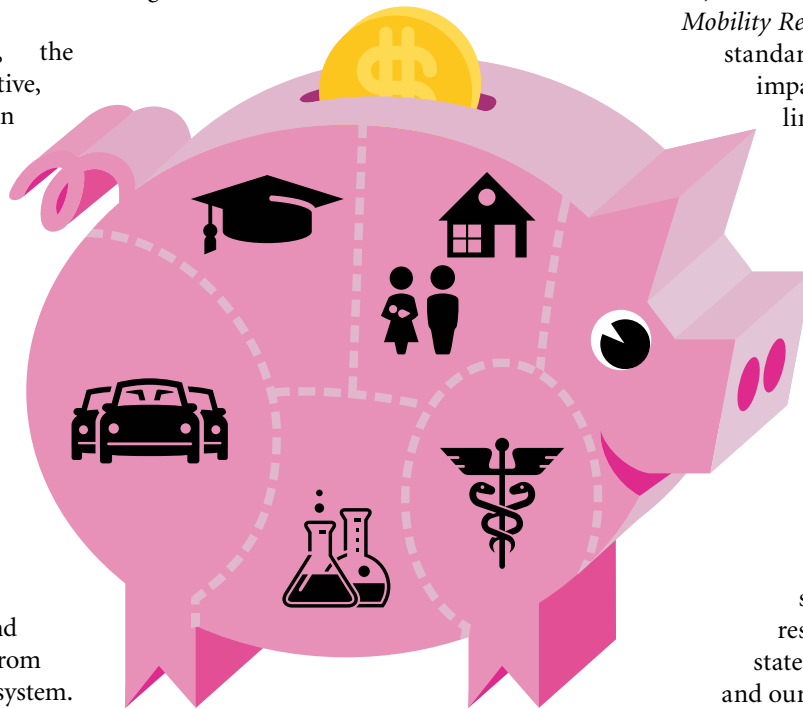
Our problems might seem local, but we see it on the news every day — the nation is tightening its collective belt. And Texas, while better off than some states, is no different. TTI research positively impacts our state's economic competitiveness and our citizens' quality of life.

We're honored that the Texas Legislature places so much faith in what we do. Making good policy, building better roadways, streamlining systems without sacrificing safety — that's the better way that makes TTI research necessary, especially when times are toughest. ■



by Dennis Christiansen
Agency Director

Our problems might seem local, but we see it on the news every day — the nation is tightening its collective belt. And Texas, while better off than some states, is no different. TTI research positively impacts our state's economic competitiveness and our citizens' quality of life.



Workshops Bring Local, State Planners Together

Every one of us likes to drive safely and without undue delays. To keep our roads safe and efficient, operators must effectively manage the existing system while simultaneously planning for evolving transportation and land development needs.

Corridor management (CM) involves land development, roadway design, access control and traffic operations along *existing* transportation corridors. In short, it's to keep roads operating safely

and efficiently. Corridor preservation (CP) addresses the preservation and protection of right-of-way, as well as acquisition of right-of-way for *future* corridors. Coordination at the local level via metropolitan planning organizations is vital to seamlessly meshing these two initiatives.

To promote better communication across agency lines, the Texas Department of Transportation (TxDOT) and Texas Transportation Institute (TTI), with sponsorship by the Federal Highway Administration, conducted workshops on corridor management and preservation at 23 TxDOT districts. These workshops resulted from a three-year TxDOT project completed by TTI in 2007.

"The workshops were successful in showing participants how to coordinate transportation and land development planning and decision making, and encouraging TxDOT and local officials to work together," says Ed Hard, TTI research scientist and project supervisor. Held between 2008 and 2010, the workshops provided training, promoted TxDOT local partnerships, and presented guidelines on developing and adopting CM/CP plans.

Bob Appleton, director of planning and development for the TxDOT Bryan District, agrees: "These workshops build relationships among government entities by encouraging cooperation and facilitating operational efficiencies across agency lines. That's sure to improve the project development process, and everyone who uses our transportation system will benefit."

Considering the current national economic situation, this coordination is crucial because "we can no longer afford not to get things done right the first time, only to have to go back and correct it in five to ten years," Hard explains. Appleton adds that state and local officials work with TTI to merge cutting-edge research and best practices into a product that TxDOT can implement around the state.

"The most important public benefit from this project is that better coordination across agencies improves the overall quality of the transportation system, which means a safer experience for all users," says Appleton. "Beyond that, improved efficiencies are passed on to the taxpayer through lower project development costs and longer-lasting facilities."

"One of the purposes of the workshops was to demonstrate specific benefits of corridor management and preservation," says TTI Senior Research Engineer Brian Bochner, one of the workshop instructors. "The participants were able to see how CM and CP could be effective in maintaining operational efficiency and facilitating future improvements." ■

"These workshops build relationships among government entities by encouraging cooperation and facilitating operational efficiencies across agency lines. That's sure to improve the project development process, and everyone who uses our transportation system can benefit from that."

*Bob Appleton,
TxDOT Director of Planning
and Development*



TTI Research Scientist Ed Hard conducts a workshop promoting improved coordination of corridor management and preservation activities between TxDOT and local agencies.



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Funding Tomorrow's Transportation in Texas

Not a Question of If ...
a Question of How

The current fuel-tax system essentially subsidizes travel by highly fuel-efficient vehicles and electric vehicles, because they pay less in fuel taxes or none at all.

We often take our transportation system for granted. Then something happens — an ice storm, for example — to remind us just how much we depend on that system. Without it, our mobility, our economy, our very lives can become paralyzed.

Keeping existing system infrastructure operational and effectively planning future roadways are vital to meeting our transportation needs. And someone has to pay for it.

Therein lies the problem. Rising fuel prices and increasingly fuel-efficient and alternative-fuel vehicles will likely decrease revenues generated by federal and state fuel taxes. (These taxes are the primary funding mechanism for the maintenance and expansion of Texas' roadways.)

"The fuel tax is a kind of 'user fee' levied on how much fuel you purchase at the pump," explains Texas Transportation Institute (TTI) Senior Research Engineer Ginger Goodin. "As people buy less gas, less revenue is generated. Meanwhile, the demands on our transportation system are only growing."

Goodin and her research team recently explored one funding alternative to the fuel tax, the mileage fee. In this system, a fee is assessed on every mile driven by a vehicle, rather than on every gallon of fuel purchased. In addition to studying existing mileage-fee implementation projects around the nation, researchers solicited input from 13 transportation stakeholder groups, a nationwide panel of technical experts, and five focus groups conducted in Texas communities of varying size and geography.

"Essentially we were evaluating whether or not Texas — as a state and as a community of people — is ready for mileage fees," says TTI Associate Transportation Researcher Trey Baker, a principal member of the research team. "And the answer from the study is — not right now."

Characteristically, Texans are pragmatic about mileage fees. While the opinions obtained in the study indicate people think

mileage fees are a good idea in principle, they were more interested in fixing the current fuel-tax-based system before implementing another funding mechanism. Other concerns voiced by participants include the need to better understand the

impact of electric vehicles on fuel-tax revenues and potentially revising how fuel taxes are currently apportioned (e.g., some fuel-tax revenues go toward education rather than highway maintenance).

One option for collecting information used in assessing a mileage fee would involve gathering detailed time and travel location data to ensure that only miles traveled in Texas would be assessed. While more accurate than an odometer-based alternative, this option piqued participant concerns about privacy. While the units wouldn't actually "track movements," they would collect data used to quantify travel.

"Right now there are numerous public acceptance barriers that make mileage fees non-viable for Texas," says Goodin. "But we're doing more research in the state and around the country to better understand these issues and how to implement this system if and when Texas is ready."

Mary Meyland, director of strategic policy and performance management at the Texas Department of Transportation, acknowledges that the issue is complex. "TTI's expertise has been vital in helping us identify the issues surrounding implementing mileage fees in Texas. Having Ginger and her team help us further evaluate this idea bodes well for our making the best decisions for Texans." ■



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Rural Transportation Planning

It's Not Just for Urban Areas Anymore

It's an unfortunate cliché these days: economic times are difficult. Federal, state and local budgets are shrinking. As communities look for ways to get more bang for their transportation buck, leveraging strengths across agencies becomes ever more important.

Metropolitan planning organizations have coordinated local urban planning efforts with the Texas Department of Transportation (TxDOT) for decades. But historically, rural areas haven't had transportation planning organizations to synchronize efforts across agencies. Texas Transportation Institute (TTI) Associate Research Scientist John Overman says that's changing.

"Rural planning organizations [RPOs] are emerging as an effective way to coordinate transportation planning in Texas," says Overman. "A research project conducted for TxDOT created a guide to help RPOs define their role in the planning process and how they can best coordinate agency efforts."

Partners in rural planning include TxDOT, RPOs, councils of government (COGs), public transportation providers, regional mobility authorities, coordinated public transit-human services planning agencies, cities and counties, and other stakeholders such as freight operators and economic development agencies. The study recommended that these partners work together to identify regional needs and coordinate various transportation projects.

The guidebook is aimed at all groups with an interest in rural transportation. That includes TxDOT district planners and engineers, COG planners, rural county judges, city and county staff, and policy makers. The guide includes an overview of the transportation planning process and requirements, and outlines how RPOs fit into the overall transportation planning process.

"Navigating the transportation planning and programming process is complicated due to the various rules, requirements, responsibilities and products involved. Rural stakeholders

new to the process need assistance in navigating the requirements," Overman explains. "The complexity of these relationships itself points up the need for the guidebook."

Overman and his team looked at RPOs across the nation to glean best practices and captured how those organizations work with their respective state's department of transportation. Researchers also spoke with various stakeholders and compared the role of RPOs with similar transportation planning efforts elsewhere.

Finally, they reviewed bylaws from existing Texas RPOs and reconciled how those should work within the framework of TxDOT's proposed transportation planning rules. Title 43, Texas Administrative Code Part 1, Chapter 16, was adopted Aug. 26, 2010, with an effective date of Jan. 1, 2011. The guidebook includes the requirements and processes presented in these rules.

"Rural planning organizations are emerging as an effective way to coordinate transportation planning in Texas. Our project created a guide to help them define their role in the planning process and how they can best coordinate agency efforts."

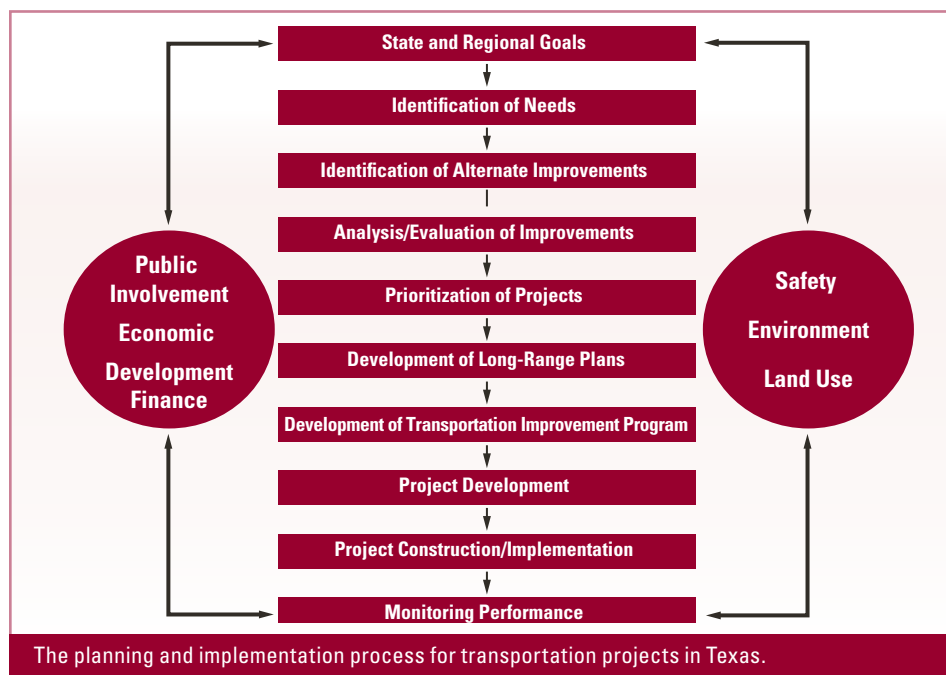
*John Overman,
 TTI Associate Research Scientist*

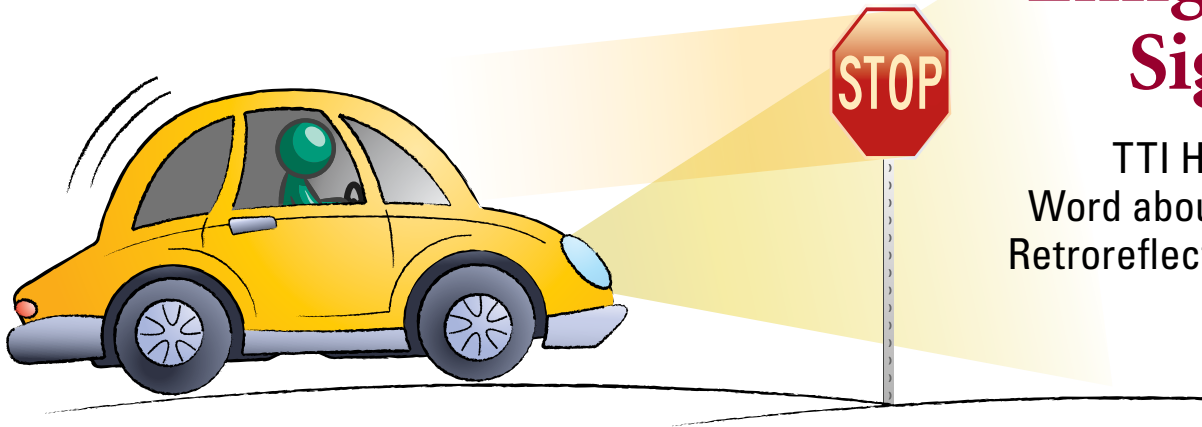
Through the end of this summer, TTI will conduct 10 workshops for COGs and districts around the state. The workshops will provide rural planners and stakeholders with a better understanding of their role in the planning process and raise awareness of available resources.

"Planning is really communicating — communicating a need and then solutions to meet the need," explains Bob Appleton, TxDOT director of transportation planning and development for the Bryan District. Appleton served as director on the project that developed the guide. "Through these workshops, we're training new regional planning organizations to appreciate and apply that rule of thumb." ■



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Enlightening Sign Time

TTI Helps Spread the Word about New National Retroreflectivity Standards

The Federal Highway Administration (FHWA) publishes the *Manual on Uniform Traffic Control Devices (MUTCD)* establishing national standards for all traffic signs. All agencies that maintain public roadways use the MUTCD to ensure signs and markings are uniform in their design and placement.

Until recently, the MUTCD did not address when a traffic sign should be replaced based on how well it reflects light, also known as its retroreflectivity. Traffic signs use small glass beads or prismatic reflectors to reflect a sign's information back to the driver's eyes.

"The retroreflectivity of a sign degrades over time due to natural — and occasionally criminal — causes," says Paul Carlson, head of Texas Transportation Institute's Operations and Design Division. "Nighttime fatal crashes occur about three times as often as daytime fatal crashes, so maintaining traffic sign retroreflectivity can be essential to safety."

The new minimum retroreflectivity requirements in the MUTCD go into effect soon. This change affects thousands of agencies and millions of signs. FHWA has extended compliance dates to ease the transition.

By January 2012, agencies responsible for traffic signs must have a sign maintenance program designed to maintain traffic sign retroreflectivity at or above specific levels. By 2015, agencies must comply with the new requirements for most of their traffic signs, including regulatory, warning and guide signs. By 2018, agencies must comply with the new requirements for overhead guide signs and all street name signs.

Sign maintenance usually occurs at the local level, but not every community has an engineer on staff familiar with retroreflectivity. To aid these agencies, Paul Carlson's team compiled a toolkit with management resources for keeping track of signs that need to be replaced without having to assess every sign.

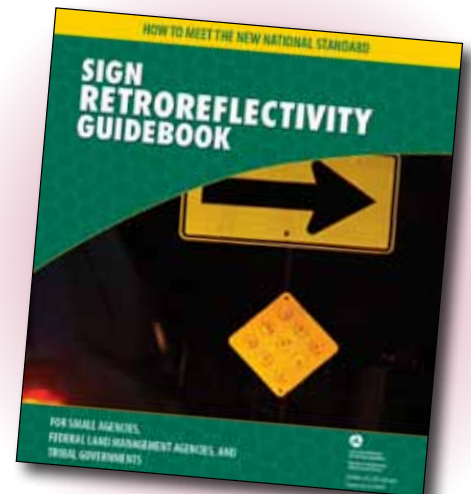
"The toolkit gives an overview of what retroreflectivity is, explains compliance and maintenance issues and provides the various forms and letters needed for funding," says Carlson.

"It provides the non-engineer some methods and strategies for maintaining retroreflectivity to the new standard."

Originally the toolkit was planned as an online resource only. After pilot testing, researchers realized there was also a need for a hardcopy version, so it's now available through the Local Technical Assistance Program (LTAP).

One of their most popular publications, approximately 60,000 copies of the guide have been printed to date.

Private companies also use the toolkit. Joanne Conrad, digital division manager for Traffic and Parking Control Company, travels around the country educating transportation professionals on traffic signs and retroreflectivity. "When we hold tech sessions on how to make a retroreflective sign, I can walk them through the *Sign Retroreflectivity Guidebook* and show them how to maintain their signs as well," says Conrad. "I carry copies with me to hand out when I do conferences and tradeshows. It's a wonderful tool for smaller agencies." ■



The guide has become very popular through LTAP, with some 60,000 copies currently in print.



FOR MORE INFORMATION

Contact Paul Carlson at (979) 847-9272 or paul-carlson@tamu.edu or see <http://tti.tamu.edu/visibility/>.



High-occupancy toll lanes, like the one seen here on Seattle's SR 167 corridor, are part of a larger strategy to relieve congestion and improve mobility in Washington State.

Express toll lanes would give drivers the option of using existing HOV lanes by paying an adjustable toll to avoid congestion in the general purpose lanes. While designed to reduce overall congestion, express lanes also generate revenue for future corridor improvements. WSDOT planners wanted input on the viability of the plan from national experts.



I-405 in Seattle, Wash., is part of the larger I-405/SR 167 corridor. I-405 is a candidate for future express toll lanes.

The WSDOT Express Lanes Project

Research into Practice

Congestion is bad and getting worse across the country. Space for new lanes is limited, and funding for new construction is nearly nonexistent.

The Washington State Department of Transportation (WSDOT) is familiar with the quandary. Its Interstate 405/ State Route 167 corridor is often congested for 10 hours each work day. The high-occupancy vehicle (HOV) lanes are so popular that carpoolers and transit riders no longer receive the travel-time savings and trip-time reliability they've come to rely on. The area is projected to grow by 1 million residents over the next 20 years.

Texas Transportation Institute (TTI) Senior Research Engineer Ginger Goodin chaired an expert review panel on WSDOT's study of the 30-mile corridor in 2009. The study suggested a system of express toll (or managed) lanes to help ease the congestion.

Express toll lanes would give drivers the option of using existing HOV lanes by paying an adjustable toll to avoid congestion in the general purpose lanes. While designed to reduce overall congestion, express lanes also generate revenue for future corridor improvements. WSDOT planners wanted input on the viability of the plan from national experts.

"We wanted Goodin heading up the team," Craig Stone, WSDOT toll division director said. "She's well respected across the country for her knowledge of projects like ours, so we were thrilled she agreed to guide the expert panel."

Goodin is considered a pioneer in managed lanes research. Working with TTI Senior Research Engineer Beverly Kuhn, she coled a TTI team in developing foundational guidance for the

Texas Department of Transportation beginning in 2000, which has supported the development of numerous managed lanes projects across Texas and the nation.

"The concept of managed lanes was fairly slow to take off," Goodin explains. "But now most new urban road projects have some element of managed lanes in the plan."

In addition to Goodin, the expert review panel consisted of Robert Poole, an independent transportation consultant; Chuck Fuhs of Parson Brinckerhoff; Jennifer Tsien of the Florida Turnpike Enterprise; and Janet Lee of Public Resource Advisory Group. Additional expertise was provided by TTI's Steve Venglar, Jeff Shelton, Phillip Reeder, Curtis Beaty and Nick Wood, who reviewed the analytical tools and methods WSDOT

planners used to develop their plan for the corridor.

The final report addresses four areas of interest, including policy, methodology, phasing and finances. In each case, the panel determined that WSDOT's plan was

viable. The Washington State Legislature will vote on the issue by spring.

"I think the work we did shows how TTI research can support the development of projects in a very practical way," Goodin said. "What we brought to the table was a respected technical team of researchers to provide expert review and independent opinion." ■

"The concept of managed lanes was fairly slow to take off. But now most new urban road projects have some element of managed lanes in the plan."

*Ginger Goodin,
 TTI Senior Research Engineer*



FOR MORE INFORMATION

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Improved *Urban Mobility Report* Distributed

The Texas Transportation Institute's (TTI's) 20th *Urban Mobility Report* (UMR) presents the most accurate picture yet of how much time commuters in 439 metropolitan areas spend in traffic and how much that congestion costs. Released Jan. 20, the report uses GPS-enabled vehicles and mobile devices to monitor traffic speeds with data from INRIX, a leading private-sector provider of traffic information.

"The recent TTI-INRIX collaboration took much of the estimation out of calculating congestion because the data reflect the actual speeds of vehicles," notes TTI Research Engineer Tim Lomax, lead author of the UMR. "Knowing exactly how fast traffic is moving, we can calculate delays fairly easily with precision not available before."

The report shows a drop in congestion from 2006 to 2007 and then, as expected, a slight increase in 2009 — thanks to a slowly improving economy and lower gasoline prices.

Researchers determined that the cumulative cost of 2009 congestion was \$115 billion in wasted time and fuel. That's \$808 for each of us, on average.

"This year's report is a remarkable game changer," TTI Associate Research Scientist David Schrank explains. "The new data address the biggest shortcoming of previous reports. The data show conditions for every day of the year and include the effect of weather problems, traffic crashes, special events, holidays, work zones and other factors directly impacting traffic flow."

As in past years, Lomax, Schrank and TTI Senior Research Engineer Shawn Turner handled a barrage of media inquiries from across the country. Nearly 400 newspapers, 60 television stations (including CNN and NBC) and dozens of radio stations printed or aired stories on the findings.

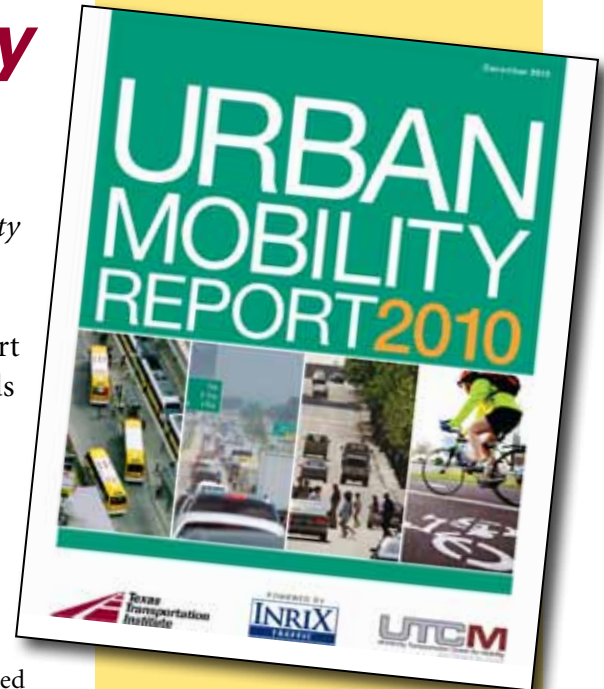
"It is about building more roads and public transportation," Turner explains. "But it's also about managing what we have more efficiently, providing more and better information to commuters,

and coordinating transportation investments and land use so that people aren't forced to drive everywhere for basic everyday services."

The report recommends a balanced and diversified approach to reducing traffic congestion, including the following strategies:

- Get as much use as possible out of the existing transportation system.
- Add roadway and public transportation capacity in the places where it's needed most.
- Change our travel patterns, employing ideas like ridesharing and flexible work times to avoid traditional "rush hours."
- Provide more choices, such as alternate routes, telecommuting and toll lanes to facilitate faster, more reliable trips.
- Diversify land-development patterns to make walking, biking and mass transit more practical.

The report determined that public transportation services and the use of roadway operational treatments like incident management programs, advanced traveler information and freeway ramp metering reduced congestion by more than 1 billion hours of delay and saved more than 900 million gallons of fuel. Those two factors alone



Based on the report, the top 10 congested areas are:

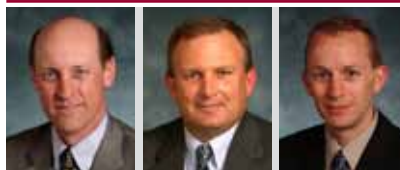
- Chicago
- Washington, D.C.
- Los Angeles
- Houston
- Baltimore
- San Francisco
- Dallas
- Boston
- Denver
- Atlanta
- Seattle

accounted for a congestion-cost savings of \$25 billion in 2009.

The presidents of the American Road and Transportation Builders Association (ARTBA) and the American Public Transportation Association (APTA) were quoted in a *Washington Post* story. Both associations are sponsors of the UMR.

"There is no doubt that expanding public transportation use is the key to reducing traffic congestion," APTA President William Millar said.

ARTBA President and CEO Pete Ruane noted, "The report makes one thing crystal clear. The failure of elected leaders at all levels of government to adequately invest in transportation improvements is taking an alarming toll on American families and businesses." ■



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Texas Lawmakers Are Increasingly Turning to TTI for Answers to Questions Like These

Is there a hidden cost to better fuel economy?

Are there alternative approaches for paying for road construction and maintenance?

What does congestion cost the typical Texas household?

Are there other ways to move freight across the border?

Sound public policy is impossible without a factual understanding of the problems at hand and a realistic grasp of the resources available. TTI's role in providing state leaders with a factual basis for public policy rests on a reputation six decades in the making.

The depth and breadth of Texas Transportation Institute's expertise in all facets of transportation are valuable assets to lawmakers charged with addressing the state's growing transportation needs. TTI has responded to an unprecedented number of information requests from individual lawmakers, legislative committees, the lieutenant governor and the speaker of the House. Here's a sampling.

Is there a hidden cost to better fuel economy?

Yes — and it's growing, according to TTI Research Scientist David Ellis. In testimony provided to the joint committee meeting of the Senate Finance Committee and the Senate Transportation and Homeland Security Committee last May, Ellis outlined the impact of key transportation finance variables including fuel efficiency, fuel consumption, debt service and vehicle registration fees. In the short term, better vehicle fuel efficiency is generating less revenue from the fuel tax at a time when road construction

and maintenance costs are rising. In the long run, electric vehicles will generate no fuel tax revenue at all to cover the costs of the roads on which they drive. The two committees sought input from Ellis regarding the effect of Texas' population growth on vehicle miles traveled, projected fuel efficiencies and construction commodity prices. ■



Alternative-fuel vehicles, while good for the environment, will definitely have a negative impact on Texas' fuel-tax revenues.



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Are there alternative approaches for paying for road construction and maintenance?

As vehicles move away from traditional fuels to energy sources like electricity, the importance of identifying new ways to finance our transportation infrastructure grows. That effort is well underway at TTI.

TTI Senior Research Engineer Ginger Goodin and Associate Transportation Researcher Trey Baker testified before the Subcommittee on Funding of the House Select Committee on Transportation Funding last October on one possible exploratory study of using vehicle mileage fees (VMFs) in Texas. A similar

briefing was held for legislative staffers prior to the current session.

Moving toward an actual “user fee” for roadways represents a significant change over the current funding system, which taxes fuel purchases as a proxy for road use. The VMF study gathered input and perspectives from Texans, as well as engaged a panel of technology experts to outline possible deployment options for such a fee. Public concerns the researchers encountered included privacy issues, administrative costs and questions about enforcement. ■



How to pay for our state’s roadways is a key question under consideration by the Texas Legislature.

What does congestion cost the typical Texas household?

In October, Ellis and TTI Research Engineer Tim Lomax appeared before the Select Committee on Transportation Funding of the Texas House of Representatives to assess congestion costs to Texas households under six different scenarios:

- current funding trend;
- increasing vehicle registration fees by \$30;
- doubling vehicle registration fees;
- spending \$4 billion annually on new construction and \$2 billion annually on maintenance;
- using Texas Emissions Reduction Plan funds to offset bond and pass-through debt and
- using oil severance-tax revenues to recapture bond and pass-through debt.

The researchers plotted two variables for each of the six scenarios:

- the impact of congestion on common consumer commodity prices; and
- the cost, in terms of both extra travel time and extra fuel, of not addressing congestion.

Two trends emerged from this analysis:

- By 2035, the annual cost of congestion for Texas households, on average, will increase from the current \$1,500 to almost \$5,400.



The costs of congestion are evident at the pump since more time spent idling during rush hour burns more fuel.

- If congestion costs were kept at current levels, every \$1 in transportation infrastructure improvements would produce an estimated \$6 in economic benefit.

The researchers found that the \$4 billion-per-year construction investment would likely result in saving the typical household \$3,390 per year by 2035, while costing each household only \$350. ■

Are there other ways to move freight across the border?

In a presentation to the Senate Committee on International Relations and Trade May 4, 2010, TTI Assistant Agency Director Steve Roop reported on the potential of a private-sector freight shuttle system to greatly improve border freight movement. The Freight Shuttle combines technology and operational strategies to provide sustainable and productive freight transportation. It’s designed to address critical freight transportation challenges, including

- increasing predictability in freight movement;
- improving productivity, measured in terms of the relationship between cost and capacity;
- reducing infrastructure deterioration by removing vehicles from public roadways;
- improving air quality and
- providing greater security, improved safety and better risk management.

Using the best features of truck and rail freight movement, the freight shuttle system is an automated, non-stop, non-divertible means of moving both containerized and trailer-based goods, Roop noted. ■



Implementing innovative ideas that work, like TTI’s Freight Shuttle, is vital to the future of the Texas economy.

Walk This Way — and Bicycle Too

CAMPO, TTI Use Pedestrian/Bicycle Counts to Improve Transportation Network

The Live Music Capital of the World has one more thing to sing about — its pedestrian and bicycle pathways.

The Austin area is committed to environmental protection and has made great strides in incorporating pedestrian and bicycle traffic into its transportation plans. Travelers using nonmotorized means enjoy scenic paths throughout the area —

Texas Transportation Institute (TTI).

TTI assisted the Capital Area Metropolitan Planning Organization (CAMPO) in examining pedestrian and bicycle pathways. To see if a transportation improvement has

actually had a positive effect, you first need baseline data — how many pedestrians and bicyclists used the path before the improvement? After the improvement, you gather data again — has the improvement drawn more users, and was the benefit worth the cost? Figuring out how to gather this information was the job of TTI researchers.

“We gathered data at 15 locations in the Austin area,” says Joan Hudson, TTI associate research engineer. “Using TTI and City of Austin cameras, we took video counts of traffic using the pathways.”

Video counts of traffic, which entail a person watching the video and counting each user, is labor intensive, so the research team also tested and evaluated new equipment for automated traffic counts. Based on these tests, CAMPO purchased two permanent counters and installed them in downtown Austin, allowing for ongoing data collection and analysis.

“We need at least one year of data to begin to identify possible use trends, which include seasonal variations and how traffic fluctuates over the day, week, etc.,” says Hudson. “The permanent counters will give CAMPO important baseline data on how people are using the route and will let the agency forecast future use.”

CAMPO also purchased portable counting equipment for use in evaluating areas for prospective improvements, such as adding a shoulder or bike lane to a roadway. Information from counters allows the agency to compare different improvement projects, in addition to later evaluating the success of the project through comparison of before-and-after data. TTI also developed tools to identify missing links in the pedestrian/bicycle network and to forecast usage.

“The forecasting method TTI developed allows us to evaluate projects and their impact on the transportation system,” says Greg Griffin, senior planner with CAMPO. “With the tools TTI has provided, we can get objective data about demand that we can use in combination with public involvement for long-range planning. This is the first step in equalizing the transportation modes.” ■

“The first installation of the two permanent bike/pedestrian counters was on the new Lance Armstrong Bikeway at W. 3rd and Shoal Creek, which is very near Lance Armstrong’s bicycle shop called Mellow Johnny’s. We had just turned on the equipment after installation and were ready to test when here comes a sharp-looking bicyclist — Lance himself. So the first Eco Counter installation in Texas was on the Lance Armstrong Bikeway, and who is the first person to be counted but Lance Armstrong himself.”

*Joan Hudson,
TTI Associate Research Engineer*

created with utility and safety in mind, in addition to their visual charms. Though patrons of these pathways see the effort’s success, it can be hard to quantify. Enter the



(Left) A worker seals the saw cut where a wire for the traffic counter was installed. The wire senses the presence of bicyclists, and the wooden pole next to the concrete path counts all trail users by direction. (Right) Workers test the traffic counter equipment by riding a bicycle through the sensor area.



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Designing Context-Sensitive Solutions for Urban Thoroughfares

Our oldest means of transport — our own two feet — is making a comeback. In the interests of sustainability, transportation planners and engineers are trying to more thoroughly and effectively integrate pedestrians and bicyclists into thoroughfare design. To help guide this effort, the Institute of Transportation Engineers (ITE) and partners like the Texas Transportation Institute (TTI) have developed a recommended practice for the design of walkable major urban thoroughfares.

Besides mobility, urban thoroughfares have economic and social functions as well, functions often forgotten in the age of the automobile. ITE's recommended practice centers on context-sensitive solutions (CSS) — meaning that planners consider all potential uses and benefits of the thoroughfare in their design.

"The process brings together stakeholders affected by the street to discuss the goals, objectives and issues of the community," says Brian Bochner, TTI senior research engineer and the technical project director. "This process builds ownership and consensus for the efforts to develop or revitalize the street."

For example, a transportation agency might need to make some changes to the roadway. That may also provide an opportunity for area businesses, the community and users of the roadway to discuss beneficial changes, such as improved lighting, wider sidewalks, etc.

"What's new about this concept is that, from the very beginning, agencies are listening to the stakeholders who live and work there, as opposed to just looking at mobility needs," says Beverly Storey, TTI associate research scientist. "They're listening early in the process, before design, and everyone works together toward their mutual goals." This approach can also save money by avoiding costly changes to design or construction, and can help agencies leverage funding.

Sponsored by the Federal Highway Administration (FHWA) and the U.S. Environmental Protection Agency (EPA), the effort to compile best practices for CSS began in 2003 in a joint effort by ITE and the Congress for the New Urbanism. Contractors TTI and Kimley-Horn led the creation of the final recommended practice, *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach: An ITE Recommended Practice*, published in 2010.

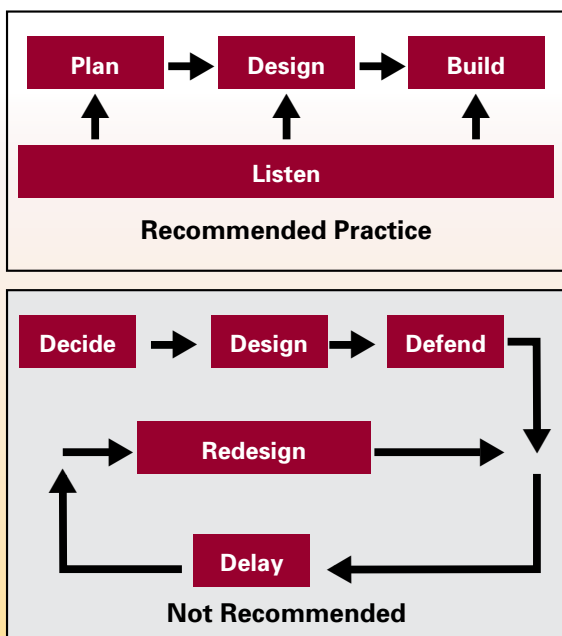
Part of TTI's role in the project was to identify issues of interest, work with a wide variety of stakeholders and help find consensus on best practices. TTI also performed outreach, giving workshops around the country to introduce the concept and get participant feedback.

"Publication of the ITE Recommended Practice served as a significant milestone for the advancement of context-sensitive design principles and concepts within the traffic engineering profession," says ITE Deputy Director for Technical Programs Philip J. Caruso. "The Texas Transportation Institute played a key role in transforming these principles and concepts into clearly defined guidelines and technical tools."

FHWA and EPA have accepted the document, and the American Association of State Highway and Transportation Officials has also accepted it as compatible with its standards. Texas and other states have incorporated all or part of it in their design policies or manuals.

"What's new about this concept is that, from the very beginning, agencies are listening to the stakeholders who live and work there, as opposed to just looking at mobility needs. They're listening early in the process, before design, and everyone works together toward their mutual goals."

*Beverly Storey,
TTI Associate
Research Scientist*



Recommended practice yields a desirable project the first time through rather than costly delays due to opposition.



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Road Safety Audit Course Offered in Abu Dhabi



Participants in the Abu Dhabi road safety audit course conduct a field exercise to identify roadway problems.

Abu Dhabi, the capital of the United Arab Emirates, looks much like urban areas in the United States. And like the United States, traffic safety is a problem. In November, Jeff Shelton, Texas Transportation Institute (TTI) assistant research scientist, traveled to Abu Dhabi to present a certified training course on road safety audits to area transportation professionals. Also, like their counterparts in the United States, participants were eager to hear what Shelton had to say and discuss their own experiences.

“They were interested in the techniques I had to share,” says Shelton. “Participants asked good questions during the field exercise. Getting out on the streets where they could see problems

“The workshop reinforced the growing interest among Abu Dhabi transportation agencies to improve safety on existing and planned roads. The most interesting part of the workshop included a site visit to an existing road to practice safety audit procedures.”

*Aizaz Ahmed,
Manager of Abu Dhabi’s
Highways Management
Policy and Strategic Planning*

Regional Congress and Certified Training. A member of the Abu Dhabi Department of Transport (DOT) asked Shelton to present the American course at the conference.

like sign overload helped them understand the principles of the course.”

Shelton is certified by the Federal Highway Administration to conduct train-the-trainer courses for road safety audits. He’s presented numerous courses in the United States, but the Abu Dhabi trip was his first international training effort. The course was part of the 2010 Second International Road Federation Middle East

“The Middle East has a lot of traffic fatalities, and they wanted to see if this tool could help them save lives,” says Shelton. “They have a lot of high-performance cars on the street, meaning higher speeds and overconfident drivers.”

The road safety audit course teaches transportation professionals how to find low-cost solutions to fix roadway problems quickly. An independent audit team conducts a formal safety performance examination to see if the road or intersection can be improved — including changes to roadway geometry and operations. Changes could be as simple as removing obstructions near the roadway, improving drainage or moving signs to prevent signage overload.

“The workshop reinforced the growing interest among Abu Dhabi transportation agencies to improve safety on existing and planned roads,” explains Aizaz Ahmed, manager of Abu Dhabi’s Highways Management Policy and Strategic Planning. “The most interesting part of the workshop included a site visit to an existing road to practice safety audit procedures.”

The field exercise included taking photos of things the participants wanted to fix and then discussing the problems in the classroom. This exercise taught students to implement the techniques they were taught in the course.

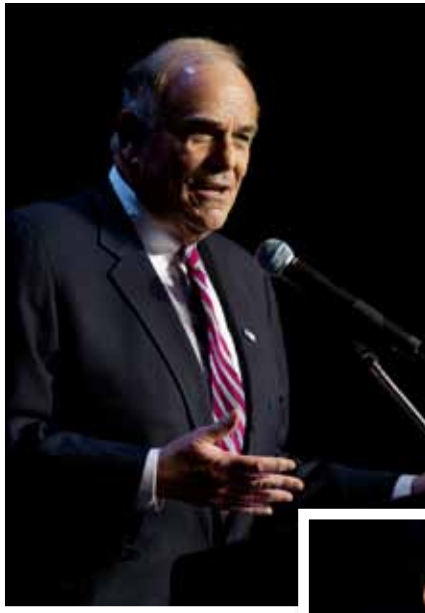
In addition to broadening TTI’s international scope and knowledge, the project helped Shelton form important relationships with transportation professionals in the United Arab Emirates. He’s currently discussing providing other courses for the Abu Dhabi DOT. ■



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Rendell Tells Texas Transportation Forum It's Time to Act



(Above) Gov. Edward G. Rendell of Pennsylvania.

(Right) Sen. Tommy Williams, chair of the Senate Committee on Transportation and Homeland Security discusses the future of transportation.



Sen. Glenn Hegar, Jr., chair of the Sunset Advisory Commission; Rep. Drew Darby, chair of the House Select Committee on Transportation Funding; Deirdre Delisi, chair of the Texas Transportation Commission; Representative Eddie Rodriguez, vice chair of the House Select Committee on Transportation Funding; and Rep. Rafael Anchia, member of the Sunset Advisory Commission, participate in a State Transportation Roundtable.

Worried about the condition of our nation's infrastructure, Pennsylvania Gov. Edward G. Rendell delivered a fiery keynote speech to the 1,200 attendees of this year's Texas Transportation Forum, held in Austin Jan. 3-5. The forum was co-sponsored by Texas Transportation Institute.

"We used to be the best at everything," Rendell said during his speech occurring days before he stepped down as governor. "Now our transportation is mediocre. What happened to us?"

The outspoken and outgoing governor made national headlines the week before when he was critical of an NFL decision to postpone a football game because of an approaching snowstorm. He continued that theme in describing America's unwillingness to tackle the infrastructure problem.

"How many bridges have to fail — how many levees have to break before we wake up?" Rendell asked.

He said there were numerous ways to raise the money for road-building projects and proposed lifting a ban to allow states to place tolls on previously existing federal highways. "May I be bold enough to suggest it's time to stop nation

building in Iraq and Afghanistan and start nation building in the USA?"

Acknowledging that solutions are 'fraught with political obstacles,' Rendell told the crowd he was in favor of toll roads, public-private partnerships and additional taxes in order to improve infrastructure. He also said stimulus funding creates jobs.

Rendell proposed a nationwide public relations campaign to help change the way Americans think about infrastructure and urged those in attendance to educate their neighbors about why it's important for the economy.

"We can win this fight, and we need you to be one of the soldiers," he said. ■



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Rendell proposed a nationwide public relations campaign to help change the way Americans think about infrastructure and urged those in attendance to educate their neighbors about why it's important for the economy.



Participants converse between sessions at the 2011 Texas Transportation Forum.

Maintaining a Strong Foundation

Materials and Pavements Implementation Projects

Tying It All Together — Corridor Analysis

Maintaining the existing highway network is one of the Texas Department of Transportation's (TxDOT's) top priorities. Many segments on important routes have now exceeded their design lives and are in need of major rehabilitation. To assist in this critical task, TxDOT contracted with the Texas Transportation Institute (TTI) to initiate a groundbreaking corridor analysis project. This new interagency agreement will permit TTI engineers to implement the products of many years of research while providing answers to TxDOT districts on the optimal approach to repair these distressed highways.

Working with TxDOT engineers, TTI has almost completed the first study on the Interstate 20 corridor in the Odessa District. "The length of the roadway is 165 miles, and it consists of 20 different pavement sections, each with different layer thicknesses and maintenance histories," says Tom Scullion, the senior

research engineer at TTI leading this effort. "The goal of the study is to develop a 10-year pavement rehabilitation plan for each section based on determining the underlying cause of the pavement problems."

The research team initially conducted a full ground-penetrating radar (GPR) survey. Then after meeting with district personnel to discuss roadway history and priorities, the team executed a falling weight deflectometer test program to evaluate the in situ structural strengths and a verification field-sampling program. For each section, the cause of the distress, the most appropriate repair strategy and the priority of the work were reported to senior district personnel.

"Priority 1 projects were identified as those that have essentially failed and need full rehabilitation in the next 2 years. Priority 4 projects are those judged structurally adequate for the next 10 years," says Scullion.



Researchers took coring samples along I-20 to determine the cause of stripping.

This project has generated substantial interest within TxDOT, and work is underway to evaluate three major U.S. routes in the Lubbock District. The team is also about to initiate an evaluation of Interstate 45 in the Bryan District. ■

An Eye Out for the Environment — Reclaiming Asphalt

In addition to conserving energy and protecting the environment, the use of reclaimed asphalt pavement (RAP) can significantly reduce the cost of asphalt mixes. These mixes continue to increase in cost, so savings benefit operating agencies. A key problem with RAP mixes is variability, which is the main reason why many state departments of transportation, including TxDOT, limit the use of RAP. In most circumstances, RAP variability is closely related to RAP stockpile management and RAP processing.

In 2010, TTI developed a set of state-of-the-practice guidelines for TxDOT regarding RAP processing and stockpile management. The principal points were to 1) eliminate contamination of RAP stockpiles, 2) keep RAP stockpiles as separate as possible, 3) blend thoroughly before processing or fractionating the multiple-source RAP stockpiles, 4) avoid over-processing, 5) use good practice when storing the processed RAP, and 6) characterize and number the processed RAP stockpiles.

"When properly designed and constructed, RAP mixes could have the same or similar performance as pure hot-mix asphalt [HMA] mixes," says TTI Associate Research Engineer Fujie Zhou. "The stockpile management practices and



The use of reclaimed asphalt pavement can significantly reduce the increasing cost of asphalt mixes.

RAP-processing techniques described in this report help TxDOT better control RAP variability." ■

Related report: *RAP Stockpile Management and Processing in Texas: State of the Practice and Proposed Guidelines*, <http://tti.tamu.edu/documents/0-6092-1.pdf>

New Technologies for Assessing Hot-Mix Asphalt Overlays

HMA overlays are a critical part of TxDOT's maintenance program, as are methods to evaluate the quality and uniformity of the overlays. In 2006, TTI began a research project to evaluate several available non-nuclear density gauges and further refinement of infrared imaging and GPR for use in evaluating HMA overlays.

The project led to the development of data collection/analysis software and a new infrared sensor bar that is mounted on the back of a paver to provide uniformity in measurement. These technologies provide a much-improved method to collect and analyze HMA-paving projects for uniformity and quality as compared to traditional spot tests.

The technologies assist with the evaluation of segregation on a project, project uniformity and overall project quality. The PAVE-IR system can provide

near 100 percent coverage of a paving project. Based upon work completed, the guidelines developed by TTI should serve to flag potentially segregated areas with thermal imaging. A new test procedure, Tx Method 244 F, has been developed by TxDOT, and in 2010, the Pave-IR system was included in the department's construction specifications. (PAVE-IR is an infrared temperature bar system developed by TTI.)

"Based upon work completed," Mikhail continues, "the guidelines developed by TTI should serve to flag



Workers use the second-generation infrared sensor bar on a paving project.

potentially segregated areas with thermal imaging."

Related report: *New Infrared and Radar Systems for Detecting Segregation in Hot-Mix Asphalt Construction*, <http://tti.tamu.edu/documents/0-4577-2.pdf>

Getting It Right the First Time — Proper Design of Asphalt Overlays

The placement of an asphalt overlay is the most common method used by TxDOT to rehabilitate existing asphalt and concrete pavements. The type of overlay and its required thickness are important decisions that TxDOT engineers make on a daily basis. To perform well, an asphalt overlay must have a balance of both good rut and crack resistance. Furthermore, overlay performance is highly influenced by many factors, such as existing pavement conditions, traffic loading and environmental conditions.

In response to the need, TTI conducted a research project with the objectives to develop 1) an HMA overlay mix design balancing rutting and reflective cracking requirements, 2) guidelines for evaluating existing pavements focusing on identifying repair locations and collecting information needed for the HMA overlay thickness design in which the primary concern is reflective cracking, and 3) an HMA overlay thickness design system focusing on reflective cracking and rutting.

In addition to three published reports, the TTI research team headed by Associate Research Engineer Fujie Zhou conducted several workshops to train TxDOT personnel on the Texas Asphalt Concrete Overlay Design and Analysis System (TxACOL). "We trained more than 30 representatives from TxDOT on how to use TxACOL software," says TTI Division Head of Materials and Pavements Andrew Wimsatt. "The attendees practiced the software step by step and by the end of day knew how to properly design an asphalt overlay using the program."

Related report: *Mechanistic-Empirical Asphalt Overlay Thickness Design and Analysis System*, <http://tti.tamu.edu/documents/0-5123-3.pdf>



The main screen of the asphalt overlay design and analysis system.



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Hall of Fame Honor

Texas Transportation Institute Executive Associate Director John Epps was inducted into the National Asphalt Pavement Association's Hot-Mix Asphalt Hall of Fame in February at the 56th annual meeting of the association in Orlando, Fla., in February 2011.

The hall of fame was "established to recognize and honor individuals who have made significant and lasting contributions to the asphalt pavement industry leading to innovations in the production and placement of asphalt pavement, in the usage of asphalt as a paving material, and in the general advancement and recognition of the industry."

The honor recognizes Epps' significant contributions to the asphalt pavement industry throughout his 40-year career. ■



TTI Executive Associate Director John Epps is inducted into the National Asphalt Pavement Association's Hot-Mix Asphalt Hall of Fame. From left to right: Jim Roberts, president and CEO of Granite Construction, Inc.; Jon Epps; Larry Lemon, chairman of the National Asphalt Pavement Association; and Jay McQuillen, vice president of Granite Construction, Inc.

TRB Appointments



Turnbull

Texas Transportation Institute (TTI) Executive Associate Agency Director Katie Turnbull has been appointed chair of the Transportation Research Board (TRB) Technical Activities Council (TAC). The TAC provides leadership for the 200 TRB standing committees. It fosters communication across committees, coordinates annual meeting spotlight themes and cross-cutting issue sessions, helps identify critical transportation issues, and promotes research and outreach initiatives.

"I am honored to have the opportunity to serve as TAC chair," notes Turnbull. "Participating in TRB has greatly enriched my professional development, and I look forward to making sure others have the same opportunities." Turnbull, who will serve a three-year term, is the first TTI researcher to serve as TAC chair.

Additionally, Paul Carlson, research engineer and head of TTI's Operations and Design Division, has been appointed to serve as chair of TRB's Operations and Preservation Group. In this capacity, he will also serve as a member of the TAC. ■



Carlson

TTI Welcomes Returning Advisory Council Member



Watson

TTI is pleased to welcome Linda Watson back to the TTI Advisory Council. Watson was named president and CEO of Capital Metropolitan Transportation Authority in July 2010. In this role, she manages Capital Metro's day-to-day operations. Capital Metro serves 10 communities and has a budget of \$164 million, 1,500 employees and 500 vehicles.

Most recently, Watson served as CEO of Central Florida's Regional Transportation Authority, LYNX. She was a member of the council previously but resigned in 2004 when she moved to Florida. She formerly served as general manager of the Corpus Christi Regional Transportation Authority and assistant general manager of the Fort Worth Transportation Authority. Watson is a past chair of the Transportation Research Board and currently serves on the National Research Council of the National Academy of Sciences, among several other board positions. She graduated from The University of Texas at Arlington with a B.A. in political science and an M.A. in urban and regional affairs, and was recently honored as a distinguished alumnus of the university. ■



Gary K. Trietsch receives the 2010 TTI State Research Champion Award from TTI Agency Director Dennis Christiansen.

State Research Champion Award

The 2010 Texas Transportation Institute (TTI) State Research Champion Award, sponsored by Trinity Industries, was presented to Gary K. Trietsch at a reception in Houston Nov. 30, 2010. Trietsch was a strong supporter of research throughout his 40-year career with the Texas Department of Transportation (TxDOT), including serving as district engineer for the Houston District and director of TxDOT's Maintenance and Operations Division. This commitment continues with his ongoing participation in the TTI Advisory Committee.

"Gary is well known for his innovative thinking, creative approach to problem solving and focus on results," noted TTI Director Dennis Christiansen in presenting the award. "His leadership within TxDOT helped advance numerous research projects that have contributed to mobility, safety and improved operation of the state's transportation system." ■

Tooley Receives ARTBA's Steinberg Award

The American Road and Transportation Builders Association (ARTBA) honored Texas Transportation Institute (TTI) Director of External Initiatives Melissa Tooley with its 2010 S.S. Steinberg Award Jan. 24.

"Some people ask what happened, some people watch what happens, and some people make things happen. Melissa Tooley makes things happen." The sentence appears on an ARTBA news release announcing the award. The quote is from an industry peer describing Tooley, who is also director of TTI's University Transportation Center for Mobility.

Tooley accepted the award in Washington, D.C., during the 90th Annual Meeting of the Transportation Research Board.

The Steinberg Award is named after the founding president of the ARTBA Research and Education Division (RED) and recognizes an



Melissa Tooley (right) receives the S.S. Steinberg Award from ARTBA RED Board Member Teresa Adams.

individual who has made remarkable contributions to transportation education.

"It is a huge thrill to receive the Steinberg Award, and all that it represents," Tooley said of the honor. "There is no greater tribute than to be recognized by my peers, especially in an organization like ARTBA." ■



For more information about these news items or other media inquiries regarding TTI research, please contact Rick Davenport at (979) 862-3763 or r-davenport@ttimail.tamu.edu.

Zimmer Receives ASTM Award



Zimmer

ASTM International presented Texas Transportation Institute (TTI) Senior Research Specialist Dick Zimmer with a Meritorious Service Award after

32 years with the organization. Zimmer began serving on the group's Vehicle Pavement System Committee (Committee E-17) in 1978.

The Meyer-Horne Outstanding Achievement Award was named after NASA Engineer Walter Horne and Penn State Mechanical Engineering Professor Wolfgang Meyer, early pioneers in pavement friction research. ■



TTI Honors Bob Skinner at TRB

Robert Skinner, the executive director of the Transportation Research Board (TRB), was honored by the Texas Transportation Institute (TTI) in Washington, D.C., Jan. 23 at TRB's Annual Meeting. The TTI Director's Research Champion Award was presented to Skinner for his support of transportation research.

"There is no better example of a transportation research supporter," Agency Director Dennis Christiansen said of Skinner, who has been the TRB executive director since 1994. "Under his leadership, TRB has expanded its scope and increased its stature. He is a true research champion."

In addition to his TRB duties, Skinner serves on numerous university advisory groups and special transportation study boards.

"I greatly appreciate this award. I have had the opportunity to work with terrific people and organizations over the years," Skinner told those attending the reception. "All of TRB shares in this award, and I thank TTI and Trinity Industries very much for the recognition." ■



TRB Executive Director Robert Skinner (center, holding plaque) was presented with the TTI Director's Research Champion Award in a Washington, D.C., ceremony. Also pictured (left to right) are TTI Agency Director Dennis Christiansen, Dianne Skinner, TTI Director Emeritus Herb Richardson and American Association of State Highway and Transportation Officials Executive Director John Horsely, also a Research Champion Award recipient.

»» TEXAS TRANSPORTATION INSTITUTE Publications

TECHNICAL REPORTS

Delivery of Workshops on Corridor Management and Preservation in Texas, by Ed Hard, **5-5606-01-1**, December 22, 2010.

Exploratory Study: Vehicle Mileage Fees in Texas, by Trey Baker, **0-6660-1**, February 1, 2011.

Field Evaluation of Asphalt Mixture Skid Resistance and Its Relationship to Aggregate Characteristics, by Eyad Masad, **0-5627-2**, December 17, 2010.

The Freight Shuttle System: Advancing Commercial Readiness, by Steve Roop, **9-1528-1**, January 13, 2011.

Implementation of Transverse Variable Asphalt Rate Seal Coat Practices in Texas, by Paul Krugler, **5-5833-01-1**, January 21, 2011.

MASH Test 3-11 of the TxDOT Portable Type 2 PCTB with Sign Support Assembly, by William Williams, **0-6143-1**, January 14, 2011.

Pavement Preservation and System Optimization Task Force, by Tim Lomax, **0-6655-TI-1**, January 31, 2011.

Planning Tools to Assess the Real Estate Leveraging Potential for Roadways and Transit: Technical Report, by Sharada Vadali, **0-6538-1**, January 31, 2011.

Safety and Economic Impacts of Converting Two-Way Frontage Roads to One-Way: Methodology and Findings, by Bill Eisele, **0-5856-1**, January 14, 2011.

Studies to Determine the Effectiveness of Longitudinal Channelizing Devices in Work Zones, by Melisa Finley, **0-6103-1**, January 13, 2011.

PROJECT SUMMARY REPORTS AND PRODUCTS

Acquisition, Uses, and Funding Options for Abandoned Rail Corridors, by Curtis Morgan, **0-6268-S**, December 15, 2010.

Benchmarking and Improving Texas Rural Public Transportation Systems, by Jeff Arndt, **0-6205-S**, December 10, 2010.

Development of Guidelines for Triple Left and Dual Right-Turn Lanes, by Scott Cooner, **0-6112-S**, January 13, 2011.

Evaluation of Longitudinal Channelizing Barricade Effectiveness, by Melisa Finley, **0-6103-S**, December 8, 2010.

Improved Positive Protection Guidance for Work Zones, by Jerry Ullman, **0-6163-S**, January 7, 2011.

Incorporating Safety into the Highway Design Process: Comprehensive Workshop, by Jim Bonneson, **5-4703-01-P6**, December 17, 2010.

Incorporating Sustainability into TxDOT's Transportation Decision Making: Updated Workshop Materials, by Tara Ramani, **5-5541-01-P2**, December 17, 2010.

Intersection Video Detection Field Handbook: An Update, by Dan Middleton, **0-6030-P3**, December 14, 2010.

Instructions for Detecting Sulfates Using the Veris 3150, by Pat Harris, **0-6362-P1**, January 26, 2011.

Is Texas Ready for Mileage Fees? A Briefing Paper, by Trey Baker, **0-6660-P1**, February 14, 2011.

Lane Assignment Traffic Control Devices on Frontage Roads and Conventional Roads at Interchanges, by Tony Voigt, **0-6106-S**, January 27, 2011.

Modeling Revenue for Use in Developing Reasonable Expectations of Revenue for Long Range Plan Development: Project Summary Report, by David Ellis, **0-6395-TI-S**, January 12, 2011.

Pre-Determining Performance Based Operational and Toll Rate Setting Measures, by Ginger Goodin, **0-6396-S**, January 3, 2011.

Portable Traffic Signal Monitoring and Evaluation Toolbox to Improve Signal Operations and Safety, by Srinivasa Sunkari, **0-6177-S**, December 10, 2010.

Rapid Field Detection of Sulfate and Organic Content in Soils, by Pat Harris, **0-6362-S**, December 15, 2010.

Realtime Monitoring of Scour Events Using Remote Monitoring Technology, by Jean-Louis Briaud, **0-6060-S**, January 7, 2011.

Rural Planning Organizations — Their Role in Transportation Planning and Project Development in Texas, by John Overman, **0-6483-S**, December 15, 2010.

Rural Two-Lane Highways Workshop: Course Notes and Slides, by Jim Bonneson, **5-4703-01-P4**, December 17, 2010.

Safety and Economic Impacts of Converting Two-Way Frontage Roads to One-Way, by Bill Eisele, **0-5856-S**, December 10, 2010.

Synthesis and Study of the Establishment and Management of Roadside Vegetation, by Beverly Storey, **0-5731-S**, December 8, 2010.

Urban/Suburban Arterials Workshop, Course Notes and Slides, by Jim Bonneson, **5-4703-01-P5**, December 17, 2010.

Workshops on Corridor Management and Preservation in Texas, by Ed Hard, **5-5606-01-P1**, January 7, 2011.

TTI PUBLICATIONS

A full catalog of TTI publications and other products is online at <http://tti.tamu.edu/> publications. You can find the publications by searching for either the title or publication number listed here. Most of these publications are available as free downloads in portable document format (PDF).

Printed, bound versions of these reports are also available through the URL above.