

# Researcher

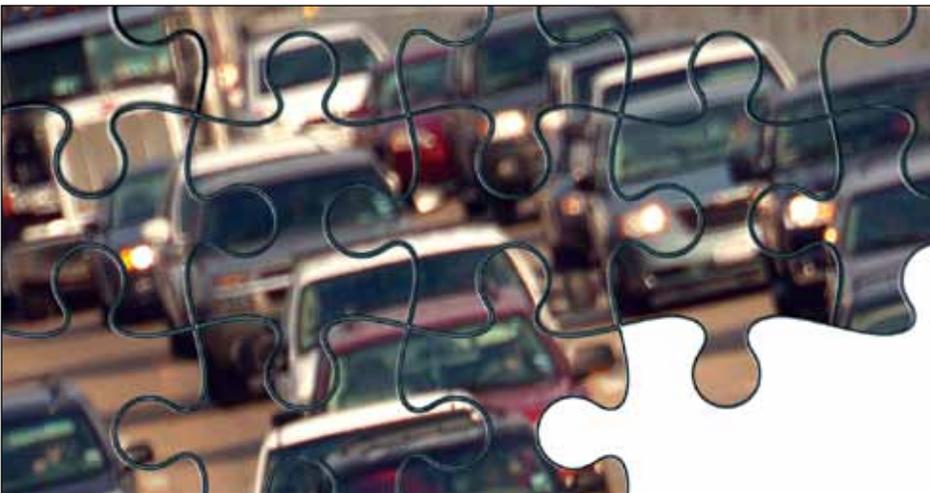
VOL. 46 | NO. 3 | 2010



## Solving the Transportation Puzzle

Mobility  
Human Factors  
Safety  
Economics  
Freight Movement

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**ON THE COVER:** The Texas Transportation Institute is performing essential research in all areas of transportation to solve today's critical issues.



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TEXAS TRANSPORTATION  
**Researcher**

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# A Horse of a Similar Color



by Dennis Christiansen  
Agency Director

**T**hings change. Technologies, economies, living conditions — thanks to human ingenuity and entrepreneurial spirit, they change over time. And yet there’s also truth in the axiom that the more things change, the more they stay the same. So what makes both of these seemingly contrasting ideas true?

In his well-known article in *The Freeman* in 2004, Stephen Davies recounts “The Great Horse-Manure Crisis of 1894.” Davies describes how attendees deserted the first international conference on urban planning after only three days, despite the conference’s 10-day agenda. Their reason? No one could find a solution to the No. 1 transportation crisis of the day — the staggering accumulation of horse manure in cities. According to Davies, “in New York City in 1900 . . . 100,000 horses produced 2.5 million pounds of horse manure a day.” Doomsayers predicted the decay of urban life by the mid-20th century as a result of this “insurmountable problem.”

Well, we know how that turned out. Electric streetcars replaced horse-drawn trolleys, and automobiles and buses soon followed. The crisis was simply innovated out of existence. And that’s Davies’ point — human ingenuity is the best insurance against any doomsday scenario actually coming to fruition.

Transportation connects all aspects of our lives: home, work, education, recreation and commerce. At TTI we see our role as helping to create a better life through innovative transportation research. TTI improves mobility, safety and economic competitiveness, and our research findings aid policy makers in coming to better-informed, forward-looking decisions. In short, we help solve transportation problems — before they really start to pile up.

Today we face crises of our own. Energy prices and availability, population growth and demographic changes, mobility needs, air and water pollution, economic unease — we use new terms like “livability” and “sustainability” to describe these concerns, but they reflect the same worries our great-grandparents shared. While they feared having enough

hay to feed all those horses, we worry about affording gasoline for automobiles. Instead of horses we worry about horsepower. The more things change, the more they stay the same.

Yet, Davies’ point about human ingenuity safeguarding the future still holds. Research at the Texas Transportation Institute (TTI) is much like Henry Ford’s design. What is invention if not finding a solution to a problem? That’s precisely the goal of transportation research.



At TTI, we study all aspects of transportation: mobility, safety, economics, freight, human factors, infrastructure, security, environment and workforce development. These aren’t merely nine research categories; they’re opportunities. Things can change — and for the better.

In this issue of the *Texas Transportation Researcher*, you’ll read about how TTI is performing essential research in the first five of these areas. (We’ll address the remaining four areas in the next issue.) Each section is followed by an expert’s commentary.

Transportation connects all aspects of our lives: home, work, education, recreation and commerce. At TTI we see our role as helping to create a better life through innovative transportation research. TTI improves mobility, safety and economic competitiveness, and our research findings aid policy makers in coming to better-informed, forward-looking decisions. In short, we help solve transportation problems — before they really start to pile up. ■

**Mobility**

Urban Mobility | Travel-Time Information Systems | HOV and HOT Lanes | Congestion Management | Rural Connectivity | Intercity Passenger Rail | Transit Mobility | Managed Lanes | Border Crossing Efficiency | Air Transportation | Transportation Demand Management | Active Traffic Management | Travel Forecasting



# The Big Squeeze

## The future of congestion management

TTI prepares the definitive national study documenting congestion costs and trends in 85 urban areas: the annual *Urban Mobility Report*. The most recent study, which was reported on by 700 media outlets across the country, provides invaluable input into policy and transportation decisions.

Gone are the days when we simply build new roads or more lanes to ease traffic congestion. Funding is limited, and — in many areas — the space is no longer available. As a result, there’s been a shift from building new highways to managing the roads we have. Mobility analysts examine problems associated with congestion and develop innovative solutions and measure their effectiveness.

Texas Transportation Institute (TTI) Research Engineer Tim Lomax is well known for his three decades of research measuring congestion and reporting the results in TTI’s *Urban Mobility Report*. Lomax’s work looks at long-term congestion trends, ranks the largest 100 metropolitan areas (in terms of delay, congestion cost and excess fuel consumed) and describes congestion improvement strategies.

“Since virtually everyone is impacted by congestion, the research we do has a lot of built-in interest,” Lomax says.

“But there’s a lot more to it than just measuring the time commuters spend in traffic.”

As congestion worsened over the last several decades, innovative strategies have been developed, implemented and measured. Some of the early strategies were as simple as timing the signal lights on arterial roadways. High-occupancy vehicle (HOV) lanes were implemented to help relieve congested roadways. Although successful in incentivizing carpooling and transit use, many of the nation’s HOV lanes have also become crowded.

### Pay As You Go

TTI Senior Research Engineer Ginger Goodin, an expert in the field of road pricing, is the principal investigator on a Federal Highway Administration project that developed a toolkit of resources for use in evaluating the need for and implementing high-occupancy toll (HOT) lanes. And along with TTI Senior Research Engineer Beverly Kuhn and other researchers, Goodin also co-authored a handbook on managed lanes. The handbook was part of a multiyear effort to assist the Texas Department of Transportation (TxDOT) in optimizing the performance of managed-lane facilities.

“What we see happening now is the growing acceptability of paying for a predictable trip,” says Goodin. “HOT lanes and managed lanes are in place in about a dozen U.S. cities, and more are being developed.”

Goodin points out that there is growing interest in pricing applied to new roads, new bridges and new lanes, both for purposes of funding the improvements and managing the flow of traffic.

### Not Just an Urban Problem

The mobility challenges facing rural communities have concerned transportation officials since the 1920s. Today, the rapid growth of many urban and suburban communities extends to the areas once known as rural, altering traffic patterns and changing local and regional economies.

TTI Associate Research Scientist John Overman examined the different approaches used by transportation planners during the development of a rural transportation system. The result of the study was a comprehensive guidebook that presented tools and strategies for planning practitioners, TxDOT engineers, administrators and transportation planning partners to address their specific transportation needs.

Overman is currently finishing a project examining the role of rural planning organizations (RPOs) in the mobility planning and programming process in rural areas of Texas. As the state seeks to improve rural mobility, RPOs will play an increasing role as forums for informed transportation

decision making. Overman's project will produce a guidebook for TxDOT districts that currently lead rural transportation planning.

### Technology to the Rescue?

Technology advancements are improving the nation's commute. For years, traffic management centers have used closed-circuit television, traffic sensors, electronic message signs and ramp meters to monitor and manage traffic. Now, many private-sector companies provide real-time traffic information based on Global Positioning System devices, included in phones and navigation devices, which help monitor the speed of traffic and point to trouble areas in the roadway network.

"With improving computer technology, more commuters are able to work from home at least part of the time," says TTI Associate Research Scientist David Schrank. Virtual home offices — utilizing the Internet, e-mail and teleconferencing — could also be a part of the solution in the future to help ease traffic congestion and save fuel. ■



#### MORE INFORMATION

For more information, please contact Tim Lomax at (979) 845-9960 or [t-lomax@tamu.edu](mailto:t-lomax@tamu.edu).



**HOT lanes provide mobility options for individual drivers while encouraging the use of transit and carpooling. Tolls collected from HOT lanes can supplement the operations, enforcement and maintenance costs for the facilities.**

## COMMENTARY on Mobility

*Ken Allen  
Senior Vice President of Supply Chain  
and Logistics  
H-E-B*

Time is money. That statement has never been truer for business than it is today. We define transportation "mobility" as a performance measure for how we move people and products. That might involve the impact on a company's bottom line or a parent's lost quality time with a child. Wasted gasoline, wasted time, declining air quality — all are signs that mobility is decreasing and congestion worsening. Time isn't just money . . . it can also be quality of life or the very air we breathe.

Texas is growing, with an expected population of over 30 million by 2030. Our transportation infrastructure isn't keeping up. "Learning to do better with what we have" is as much a moral imperative as a strategy these days. We simply can't build our way out of transportation problems anymore.

Figuring out how to improve mobility is one way to do better with what we have. The Texas Transportation Institute's (TTI's) expertise in this area helps businessmen like me look ahead so we can better meet our customers' needs. Not much is more important to a business than a clear picture of what's to come.

Beyond its internationally recognized *Urban Mobility Report*, TTI has contributed to improving mobility in other ways. For example, improved safety through roadside devices means smoother traffic flow. That's important to me in a just-in-time world because I have to get perishable goods to my stores in a timely manner. I'll lose customers if they have to stare at an empty shelf and ask, "Where's my milk?" TTI helps me keep from having to answer that question.

We speak of Texas transportation costs in billions of dollars. Even though it's sometimes not as easy to quantify, we shouldn't lose sight of just how much TTI contributes to our state's fiscal well-being.

The 2010–2011 Texas transportation budget — \$17.1 billion.

The estimated cost of Texas transportation needs by 2030 — \$315 billion.

The value of TTI research — priceless.



Economics

Revenue and Expense Forecasting | Innovative Financing | Congestion Pricing | Economic Analyses | Policy Analyses | User Fee Alternatives | Transportation Needs Estimation | Investment Decision Support | Data Integration and Management | Cost-Savings Measures | Performance Management | Freight Transportation Rate Analysis

# What Goes Around Comes Around

Transportation drives economic prosperity



Photo courtesy TxDOT

airports and trucking to infrastructure and financing. At the macro-economic level, whole business sectors depend on maintaining their transportation relationships to remain competitive. A current TTI project is helping a soybean trade association forecast future importing and exporting cost increases due to added U.S infrastructure costs and the financing involved. The goal is to determine how increased transportation costs will impact the ability to compete internationally.

Reducing travel times for commercial vehicles at U.S./Mexico border crossings could have a significant economic impact on both countries. TTI researchers are developing a border-crossing traffic simulation model to measure traffic movement during lane closures and other incidents, examining advanced technologies that provide real-time information on crossing times and delays and analyzing freight flows at different crossings. These activities also consider policy makers' concerns with border security.

Assessing the benefits and costs associated with transportation projects is becoming more important with federal stimulus programs and other economic development efforts. Construction costs are easy to add up, and benefits like reduction in crashes or fatalities are relatively easy to measure. However, categorizing and quantifying other benefits associated with such factors as livability, sustainability or economic competitiveness are much more difficult, as is linking benefit-cost analyses (BCAs) to established performance measures.

"Measuring livability and global competitiveness benefits are important," notes Katie Turnbull, executive associate agency director for TTI and director

TTI researchers are actively seeking solutions to fund the nation's transportation infrastructure.

**M**oney makes the world go 'round. In the classic 1873 Jules Verne novel, *Around the World in Eighty Days*, Phileas Fogg races the clock, traveling by boat, rail, hot-air balloon, stage coach and elephant in hopes of winning £20,000. Today's rapidly changing technology is making *virtual* world travel an everyday occurrence. But as long as real people and goods have to get to real places, transportation will play a vital role in global economics.

"Measuring livability and global competitiveness benefits are important. The center provides opportunities for research and outreach on enhancing BCA to incorporate these and other topics."

Katie Turnbull,  
TTI executive associate agency  
director and director of TTI's  
Transportation Economics Center

"You have to look at economics in a broader perspective because things seemingly unconnected to transportation actually have a great impact on it," says David Ellis, research scientist with the Texas Transportation Institute (TTI). "Looking at things from a system view, you can understand how many components impact each other."

The systems perspective requires a breadth of expertise — from rail, ports,

## COMMENTARY on Economics

*Jack Wells*  
Chief Economist  
U.S. Department of Transportation

When you boil it down, economics is the study of getting progressively better output from a given input. That concept is central to transportation today — resources are limited, demand is growing, and capacity is increasingly inadequate. So the question becomes, how do we get more bang for our transportation buck?

Our transportation system faces several key problems. Congestion is one of these — the Texas Transportation Institute’s (TTI’s) series of *Urban Mobility Reports* has documented the growing extent and intensity of this problem.

A second key problem is clarifying what objectives we want transportation to serve. For years, the primary goal of the transportation system has been simply “mobility” — as if the purpose of transportation is, simply, transportation. The Obama Administration is trying to articulate more clearly that we don’t want mobility for its own sake, but to advance goals like economic competitiveness and livability. A third key problem is how to pay for all the investment in transportation infrastructure that is needed. A fourth key problem is how to select the best transportation projects in which to invest our limited supply of investment funds. The Obama Administration is pushing for expanded use of economic analysis techniques — including benefit-cost analysis, cost-effectiveness analysis, and asset management techniques — to inform the project-selection process.

The U.S. Department of Transportation (U.S. DOT) recently created the Transportation Economics Center at TTI to mobilize the resources of the transportation economics community nationwide and bring them to bear on the key policy problems that U.S. DOT is trying to solve. For example, one key issue in measuring the benefits of alternative transportation projects is measuring the value of the time saved in transporting people and goods.

We have reasonably good measures of the value of passenger time, but we have little in the way of measures of the value to shippers of reducing the time (and increasing the reliability) involved in moving freight to its destination. We need better research on this and other key transportation policy questions. TTI’s strong background in transportation policy research makes it well suited to bring together the work of transportation economics researchers nationwide.



Reducing travel times for commercial vehicles at U.S./Mexico border crossings could have a significant economic impact on both countries.

of the Institute’s Transportation Economics Center. “The center provides opportunities for research and outreach on enhancing BCA to incorporate these and other topics.” The center recently assisted the U.S. Department of Transportation in hosting a best-practices workshop for conducting BCAs, enabling experts to share lessons learned.

Budget shortfalls often prevent transportation projects from going forward. When the Interstate Highway System first began, the gas tax — charged as cents per gallon sold, not by the price of a gallon of gas — was proposed as the best proxy user-based fee. But recent technological advancements save motorists money at the pump as vehicles become more fuel efficient and alternatively powered vehicles become more popular. As the amount of gas consumed slowly drops, the gas tax revenue decreases with it. Since most Texas highway construction and maintenance money comes from this source, a major funding problem looms on the horizon. Compounding the

problem is the rising price of roadway construction.

TTI researchers see an economic perfect storm on the horizon. “The gas tax has been so invisible, most motorists don’t know there’s a problem,” says Ginger Goodin, senior research engineer. “We’re looking at what could happen in 20 years. Now is the time to start testing solutions.”

Goodin’s team is researching new funding options to consider, such as a fee based on mileage and congestion pricing strategies. TTI is also currently evaluating congestion pricing around the country and helping other states become proactive in using managed lanes.

From funding mechanisms to infrastructure design to border security, TTI researchers are seeking innovative answers to the age-old question: How do we pay for this? ■



### MORE INFORMATION

For more information, please contact Katie Turnbull at (979) 845-6005 or [k-turnbull@tamu.edu](mailto:k-turnbull@tamu.edu).

**Freight Movement**

Universal Freight Shuttle | Freeway Truck Operations | Freight Rail | Multimodal Freight Transportation | Ports and Waterways | Supply Chain Management | Trade Globalization | Border Freight Mobility | Intermodal Trucking



# Shipping to the Future



TTI's futuristic Freight Shuttle will serve as a partner to other modes of freight movement, helping achieve an efficient balance of shipping choices.

**B**usiness and individual needs for product delivery continue to evolve due to technological advancements, economic globalization, increasing competitiveness and changing market demand. The Texas Transportation Institute (TTI) is investigating innovative solutions that support the use of multiple modes of transportation, facilitate freight transfer, reduce traffic congestion, improve air quality, and provide alternative fuel and funding options.

“Freight transportation is a dynamic environment, and innovations that result in higher efficiency or lower costs quickly change the way freight moves,” says Steve Roop, assistant agency director of TTI. “Nobody likes to pay to transport freight, so low-cost solutions have a considerable potential return on investment.”

Despite rapid incremental changes in freight transportation, significant

innovations are rare. Major changes in freight shipments have materialized only every 50 years or so — horse and wagon to railroads to motorized vehicles to just-in-time deliveries. According to the 50-year theory, the next major change is due, and TTI research has identified a key candidate — the Freight Shuttle.

TTI's Freight Shuttle concept consists of electric vehicles running on

specialized guideway rails. An automated control system with few moving parts and no onboard drivers transports cargo containers along the rails. The Freight Shuttle system is a natural complement to trucking, water and rail operations, serving as a short-distance shipping partner as well as a long-distance option.

“The Freight Shuttle will produce two public revenue streams,” says Roop. “The first comes from leasing public facilities and right-of-way, and the second is from resources saved by reducing pavement damage, decreasing maintenance and relieving congestion. The public also benefits through improved safety and air quality.”

TTI researchers are also working with the Texas Department of Transportation and other sponsors on projects to



Marine shipping contributes a fundamental component to the nation's overall freight system.

discover further innovative multimodal freight solutions, such as improved grade-crossing warning systems, tank-car placards, alternative fuels and emissions-reduction strategies.

Another way to prevent potential freight-movement disruptions is through balancing transport across transportation modes and regional boundaries. An upcoming TTI project being undertaken in cooperation with the National Center for Freight and Infrastructure Research and Education at the University of Wisconsin-Madison will look at air-cargo operations and activity levels in the 10-state Mississippi Valley Freight Coalition region. Researchers will inventory regional facilities, classify cargo types and examine market demand. The project team will develop resources for planners to use in connecting intermodal traffic to air-cargo operations.

“This project will establish a better understanding of the air-freight system in the Midwest and, ultimately, provide a basis for a long-term strategic plan to integrate increasing air-cargo demand into a coordinated freight system,” says Jeff Borowiec, associate research scientist in TTI’s Economics, Trade and Logistics Program.

In overland freight, truck traffic on roadways has outpaced growth of the roadways themselves, creating a need for ways to prevent congestion and unpredictability of deliveries. In response

to the growing number and size of trucks on Texas roads, current TTI projects are exploring management of oversize and overweight truck loads. Other possible solutions include onboard warning systems and advances in highway design in primary truck corridors.

For waterborne freight, a critical component of the freight circulation system, TTI researchers are looking for ways to capitalize on the benefits of waterborne transportation, including air-quality credits for low emissions and ways to maximize the use of unused waterway capacity.

“Achieving a proper balance of road, water, rail and air transportation that moves freight most efficiently will be important in the coming years,” says Curtis Morgan, manager of TTI’s Multimodal Freight Transportation Program.

Whether it travels by road, rail, water or air, freight that moves safely, efficiently and cost-effectively keeps our state and national economies thriving. TTI research is providing a basis for future innovations that will move freight quickly and safely, and serve individuals and businesses dealing with rapidly changing economic and social needs. ■



#### **MORE INFORMATION**

For more information, please contact Steve Roop at (979) 845-8536 or [s-roop@tamu.edu](mailto:s-roop@tamu.edu).

## **COMMENTARY** on Freight Movement

*Randy Mullett*  
Vice President for Governmental Relations  
Con-way Freight

Freight movement is the lifeblood of our economy. The recent economic downturn proves that every sector depends on moving products efficiently to keep the economy itself moving forward.

Historically, the goal of increasing efficiency has been a hallmark of the freight industry as it has evolved in America. Speed, capacity and reliability were the measures of that success as technological innovation and consumer demand drove the way we shipped products. As the world’s economies have become more interdependent, new markets have developed, bringing with them both opportunities and challenges. The opportunities are obvious; the challenges less so.

For example, different countries have different weight regulations for goods crossing national borders. Freight packaged and loaded one way in China must be repackaged before entering the United States and vice versa. These days the inefficiencies in the system are less related to technology than policy. In fact, thanks to advances in information technology, innovations like just-in-time inventories allow us to invest dollars in research and development instead of renting warehouses.

The near future will see significant changes in the way freight moves. Rising middle classes in China and India will create huge markets for U.S. manufacturers. Our previous example of packaging and repackaging goods is an unacceptable inefficiency if we’re to fully exploit those markets. Further, the intersection of shifting markets, climate change and technological innovation challenges us to find a better way to move goods.

Moving freight is and will continue to be vital to our way of life. Good policy depends on decision makers having reliable research by unbiased agencies like the Texas Transportation Institute. These data are critical to shaping sensible regulations aimed at maximizing opportunity, preserving safety and creating market share. We have the rare opportunity to know with some certainty the role freight movement will play in the next few decades. Shaping that future begins in the present.

# Celebrating 60 Years of Innovation

*A history of saving lives, time and resources*

The original 1950 charter of the Texas Transportation Institute (TTI), given by the Texas A&M Board of Directors, charged the Institute with enlisting the broad resources of the college in all forms of transportation research, while giving students the opportunity to study and work in the transportation profession. This agreement solidified the Cooperative Research Program between the then-Texas Highway Department and TTI. Over the last six decades, TTI has provided accurate and timely research to address the state and nation's most pressing transportation concerns. TTI research recommendations have consistently delivered results to its research sponsors — now numbering more than 200 annually around the globe. The world has been transformed since 1950. Today's transportation challenges are magnified many times over in size, scope and importance to our economy and quality of life. The need for results-oriented transportation research has never been greater.



**MORE INFORMATION**  
For more information, please contact Terri Parker at (979) 862-8348 or [t-parker@tamu.edu](mailto:t-parker@tamu.edu).



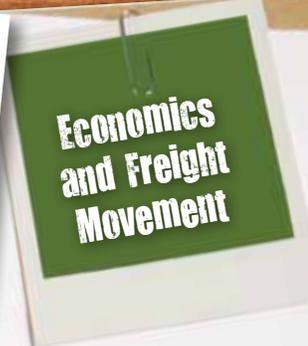
Right: Texas A&M University Associate Professor Emeritus Rodger Koppa, one of the pioneers of human factors research at TTI, specialized in the design of adaptive equipment for disabled drivers. Hundreds of disabled citizens have benefited from his research over the years.



Left: Dr. Teddy J. Hirsh's research team invented the "Texas Crash Cushion" in the 1960s. Fatalities due to collisions with concrete abutments were completely eliminated in Houston, going from 27 in seven years to none in the two years following its installation on Houston freeways. Here, Hirsh and his team examine a successful crash test with then-Secretary of Transportation Alan S. Boyd and his wife.



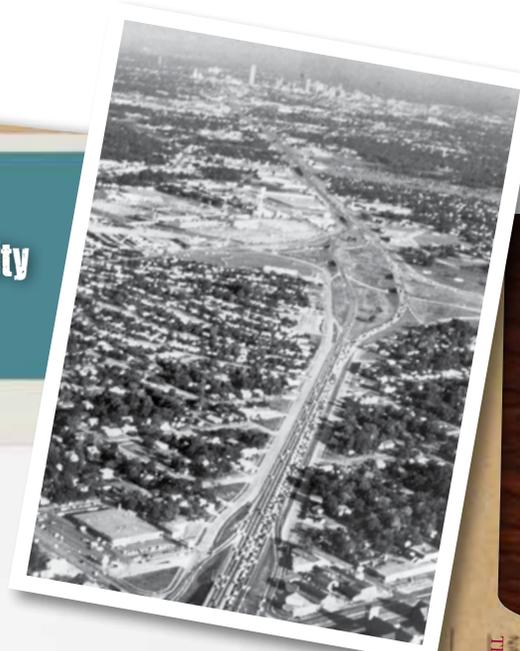
Left: (left to right) In this photo from 1968, Texas A&M President Earl Rudder, Under Secretary of Transportation Everitt Hutchinson, Dean Fred J. Benson and State Highway Engineer Dewitt C. Greer look at a model used to study various types of grade crossing situations.



Left and right: Early economic and freight studies at TTI focused on estimating future needs of the trucking, rail, water and airline industries; improving safety at rail grade crossings; and developing the Interstate Highway System.



Above: Charles Blumentritt (seated) discusses traffic programming using a then-state-of-the-art IBM 7094 computer. Standing left to right are Charles J. Keese, Charles Pinnell and Joe Wright.



Above and left: TTI researchers began their quest for better freeway operations in 1961 through work on Houston's Gulf Freeway and the North Central Expressway in Dallas. These projects were some of the first in the country to use time-lapse and aerial photography to develop mathematical models for use with new technologies and techniques such as ramp meters and computer-driven traffic surveillance and control centers.

NAME  
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NAME  
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*Fred Benson*  
Director, 1955–1962



*Jack Keese*  
Director, 1962–1976



*Charley Wootan*  
Director, 1976–1993



*Herb Richardson*  
Director, 1993–2006



**Human Factors**

Driver Behavior ■ Public Education and Outreach ■ Distracted Driving ■ Impaired Driving ■ Driving Simulator Testing ■ Eye-Tracking System ■ Roadway Visibility ■ Data Collection and Monitoring ■ Traffic Law Enforcement ■ Traffic Control Device Design and Evaluation ■ Roadway Warning Systems ■ Surveys and Focus Groups ■ Occupant Protection

# Factoring in the Human Equation



TTI is home to special facilities designed for improving driver safety. Facilities include a fully interactive driving simulator and instrumented vehicle with an eye-tracking system to measure driver behavior based on various driving speeds and conditions.

**D**uring the 1930s, several states proposed laws to prohibit the use of radios while driving. According to automobile historian Michael Lam, “Opponents of car radios argued that they distracted drivers and caused accidents, that tuning them took a driver’s attention away from the road, and that music could lull a driver to sleep.”

While technologies have evolved — substitute cell phone for radios in the above scenario — the central issue of how humans react to and behave in their driving environment remains the

same. Human-factors research involves both cognitive and ergonomic factors, according to Senior Research Scientist Sue Chrysler, the Texas Transportation Institute’s (TTI’s) current human-factors research program manager.

“Human factors’ is an umbrella term for several areas of research: human performance, technology design and human-computer interaction,” explains Chrysler. “It’s important for all driver communication — from the simplest traffic sign to the latest high-tech gadget.”

Chrysler’s group is involved in research projects across the entire breadth of human-factors topics, including “distracted driving.” This hot topic today represents the same concerns raised by opponents of car radios some 80 years ago — how drivers balance interacting with technology while keeping their eyes on the road and their minds on driving.

The idea that culture itself drives human behavior has recently made its way into human-factors research as well. “People are driving more and faster these days,” explains TTI Senior Research Engineer Shawn Turner. “The culture is one of being time conscious. That’s where you have people reading the paper or checking their e-mails while sitting in traffic or at a red light.” Turner’s research has focused on bicycle and pedestrian issues: improving pedestrian safety at unsignalized roadway crossings, updating the Federal Highway Administration’s (FHWA’s) university course on bicycle and pedestrian transportation, and conducting the international scan of pedestrian and bicyclists safety and mobility in Europe.

Though numerous roadside safety innovations over the past half-century have made a huge difference in savings lives, John Mounce, director of TTI’s Center for Transportation Safety (CTS), thinks those were the “easiest” improvements to make.

“Too many drivers think it’s their right to drink alcohol, text or be aggressive behind the wheel. It seems to be part of our culture,” acknowledges Mounce. “In human-factors research, we’re talking about creating a safety culture — a recognition of personal responsibility related to behavior and promoting traffic safety in each and every one of us.”

“People are driving more and faster these days. The culture is one of being time conscious. That’s where you have people reading the paper or checking their e-mails while sitting in traffic or at a red light.”

*Shawn Turner,  
 TTI senior research engineer*

To encourage this behavioral change, CTS has teamed with the Texas Department of Transportation (TxDOT) and the Texas Department of Public Safety to develop a new statewide motorcycle safety awareness campaign. “Someone dies nearly every day riding a motorcycle in Texas,”

says Carlos Lopez, former director of TxDOT’s Traffic Operations Division and currently the engineer for the Austin District. “Educating both motorcycle riders and drivers is essential to improving motorcycle safety and saving lives.”

Teens in the Driver Seat (TDS) is arguably TTI’s most successful program dedicated to behavioral change — in this case in teen drivers. An in-school, peer-to-peer program that focuses on the principal causes of teenage fatalities, TDS has been implemented in 300 Texas schools and is spreading to other states. Research has found that awareness of the common crash risks for teens (nighttime driving,

speeding and distractions) improved 40 to 200 percent at schools with TDS programs. Seat-belt use increased an average of 11 percent, and cell-phone use/texting dropped 30 percent. In 2009, TDS was given the Roadside Safety Award by FHWA and the Roadway

Safety Foundation for its work with teens.

In the future, human-factors research will evolve along with the driving public. “By 2020, 20 percent of the population will be over 65, so issues with the elderly will drive our future research,” says Chrysler. “But that’s only one area we

know of — there are others we haven’t yet begun to imagine. This is an all-encompassing and evolving field of research.”

“Someone dies nearly every day riding a motorcycle in Texas. Educating both motorcycle riders and drivers is essential to improving motorcycle safety and saving lives.”

*Carlos Lopez, former director of TxDOT’s Traffic Operations Division and currently the engineer for the Austin District*



**MORE INFORMATION**

For more information, please contact John Mounce at (979) 458-3346 or [j-mounce@tamu.edu](mailto:j-mounce@tamu.edu).

**COMMENTARY on Human Factors**

*Paul Green  
Past President  
Human Factors and Ergonomics Society*

Prior to the Industrial Revolution, most things were built by hand. If a farmer needed a plow, he or she made it himself. The finished handle fit his hand because he designed it to fit, and over time, as the farmer’s needs changed, he could change the design of the plow. However, that personal touch was lost when the assembly line automated production, shifting the focus from user needs to the most cost-effective, timely way to make the product.

This was true across all industrial sectors, including transportation. Ralph Nader’s 1965 book *Unsafe at Any Speed* revolutionized automobile safety by highlighting an industry’s seeming disregard for vehicle safety. That book and related activities spurred the funding of automotive safety research, the development of university research programs, and the passage of government regulations promoting safety. An important theme of that work was assessment of the human element.

Founded well before the Nader era, the Texas Transportation Institute (TTI) represents forward thinking by the Texas Highway Department and Texas A&M University. Quite frankly, for any question about driving and road design, TTI has always been the go-to place. TTI’s leadership in national organizations, such as the Transportation Research Board, demonstrates the Institute’s unwavering commitment to research excellence and application in a world that, all too often, focuses only on the promise of the next quarter.

In the future, TTI will continue solving the transportation problems we face — dealing with even more road congestion, finding ways to reduce transportation-related energy needs, and introducing new systems to automate driving and enhance safety. Even the most automated systems have a human being as a vital component. Thus, human-factors research will continue to be essential. A particularly important challenge for the future is to develop the next generation of human-factors engineers and scientists to address these issues — something TTI and Texas A&M are well positioned to do through their partnership.



*Drink. Ride. Lose.* is an anti-impaired-riding campaign to raise awareness about the consequences of riding after drinking alcohol. The campaign aims to make riders aware that drinking after riding can lead to DWI arrest and conviction, serious injury or death.

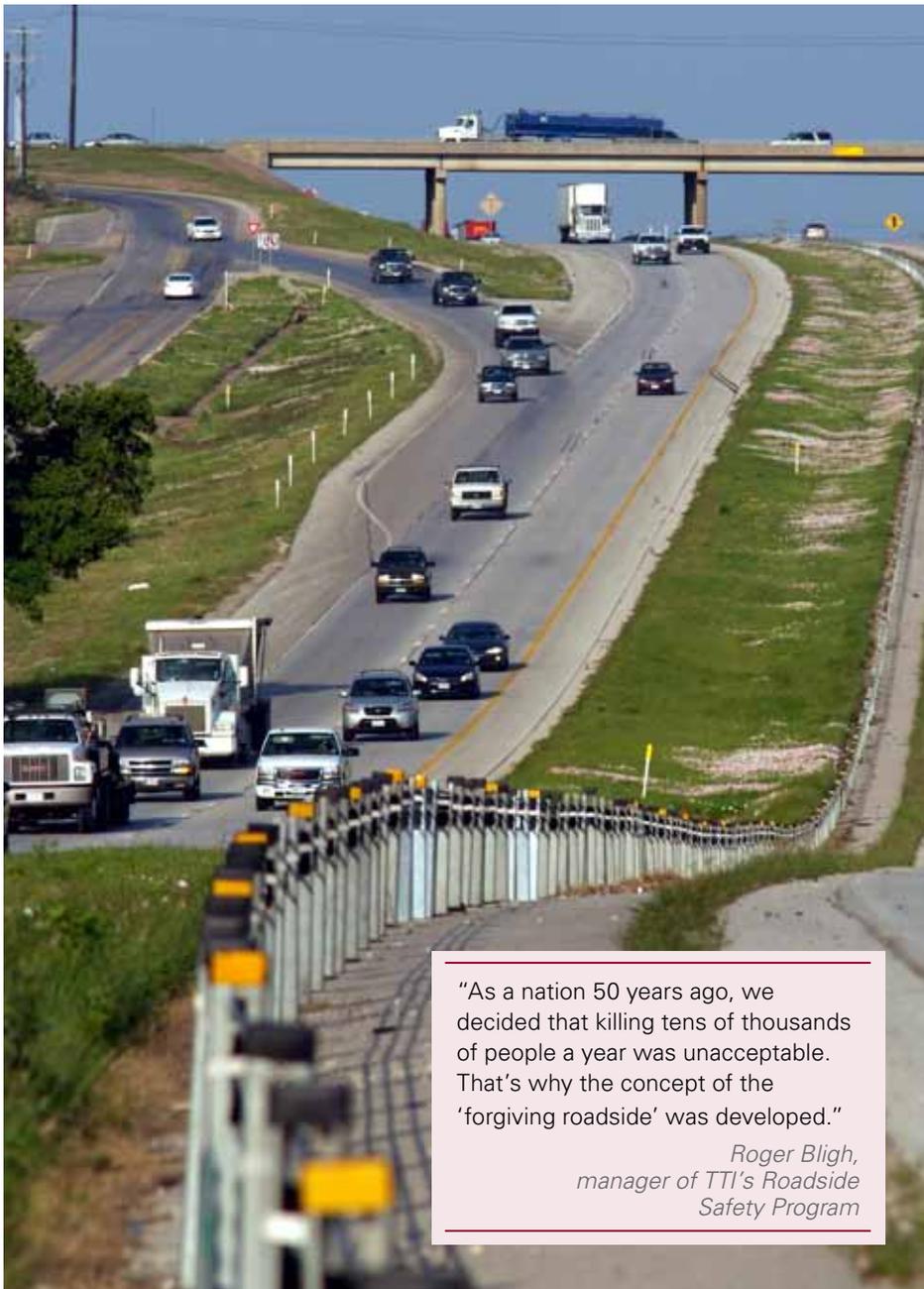
Safety

Roadside Safety | Work Zone Safety | Teen Driver Education | Hurricane Evacuation Planning | Traffic Operations | Motorcycle Safety | Railroad Crew Resource Management | Traffic Incident Management | School Bus Safety | Bicycle and Pedestrian Access | Pipeline Safety and Operations | Roadway Geometrics | Retroreflectivity | Right-of-Way Access | Crash Analysis



# The Forgiving Roadside

TTI research, facilities are vital to protecting your loved ones



“As a nation 50 years ago, we decided that killing tens of thousands of people a year was unacceptable. That’s why the concept of the ‘forgiving roadside’ was developed.”

*Roger Bligh,  
manager of TTI’s Roadside  
Safety Program*

It’s five times safer to travel on our nation’s roadways today than it was five decades ago. For every 100 million miles Americans traveled in 1960, five people died. Today, the rate has dropped to just over one death per 100 million miles.

“As a nation 50 years ago, we decided that killing tens of thousands of people a year was unacceptable,” says Roger Bligh, manager of Texas Transportation Institute’s (TTI) Roadside Safety Program. “That’s why the concept of the ‘forgiving roadside’ was developed.”

In the 1960s, TTI led the safety movement on the new Interstate Highway System by conducting crash tests on signs, guardrails and crash cushions at its Proving Ground Research Facility, the Institute’s crown jewel for improving roadside safety.

TTI’s technological innovations can now be seen on virtually every mile of roadway in Texas. Since TTI researchers created the earliest versions of the slip-base breakaway signs in the 1960s, more than 2,000 crash tests have been conducted at the Proving Ground, which recently gained accreditation by the American Association for Laboratory Accreditation for “technical competence in the field of mechanical testing.” Today, the facility also includes the Center for Transportation Computational Mechanics, where analysts run computer simulations to evaluate potential roadside safety solutions before performing the actual crash.

Perhaps TTI’s most recognizable contribution to the forgiving roadside is the ET2000® guardrail end treatment. Developed in 1991, over half a million units have been installed throughout the United States and around the world. The ET2000® absorbs energy from a crash by deflecting the guardrail away from the impacting vehicle.

Cable barriers installed on a stretch of IH 20 in Texas. Cable barriers have proven very cost effective in reducing head-on collisions across traffic lanes while slowing down vehicles with minimal impact on their occupants.



TTI research in work-zone safety includes its award-winning National Work Zone Safety Information Clearinghouse.

Recently, TTI helped develop and crash-test more forgiving median barriers made of cables rather than concrete. Concrete barriers continue to serve an important role in separating traffic on urban highways with narrow medians, but cable barriers have proven very cost effective in reducing head-on collisions across traffic lanes while slowing down vehicles with minimal impact on their occupants. The result has been a dramatic decrease in cross-median collision fatalities where cable median barriers have been implemented in the United States.

“Passenger vehicles can hit the cable, and most of the time they just drive off,” explains Marla Jasek, director of transportation operations for the Texas Department of Transportation Yoakum District.

But the forgiving roadside doesn’t maintain itself. Crews work to improve and repair roadways while drivers speed by, creating danger for both workers and drivers. An estimated 1,000 people are killed and 45,000 are injured in United States roadway work zones each year.

Portable concrete barriers are an integral part of the work-zone safety equation, shielding motorists and protecting workers. TTI continues to develop new barrier alternatives that offer designers safe and effective solutions for

restricted work-zone sites. The new X-bolt connection reduces the deflection of free-standing barriers to less than 2 feet, and a drop-pin anchorage system permits portable concrete barriers to be installed along the edge of a bridge deck.

TTI is also promoting work-zone safety through its award-winning National Work Zone Safety Information Clearinghouse (<http://www.workzonesafety.org>), the world’s largest Internet resource on all things related to work-zone safety. The clearinghouse is a project of the American Road and Transportation Builders Association and is operated in cooperation with the U.S. Federal Highway Administration and TTI. Since the site

went online in 1998, it has assisted half a million users from every state and 27 countries with a variety of topics related to safety issues in work zones.

“We have all come together to make a real difference in making work zones safer,” says Jerry Ullman, manager of TTI’s Work Zone and Dynamic Message Signs Program. ■



#### **MORE INFORMATION**

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## COMMENTARY on Safety

by *Mary McDonough*  
Roadway Departure Program Manager  
Federal Highway Administration

“Roadway departure” refers to vehicles crossing a center or edge line or otherwise leaving a roadway. Crashes from roadway departure account for over half of U.S. fatalities. Causes of leaving the roadway include use of alcohol and cell phones, speeding and distracted driving. Some die from these crashes. Many more suffer incapacitating, lifelong injuries. They and those who know them are profoundly changed by these events.

What most people don’t realize is that the deadliest place to drive isn’t a busy freeway or a high-speed interstate. It’s a two-lane rural road. Horizontal curves, pavement drop-offs, narrow lanes, and trees and poles next to the roadway — all pose serious dangers on these roads.

Roadside safety countermeasures have dramatically improved in recent decades. Guardrail end treatments, breakaway signs, cable median barriers and other technological innovations keep millions safe when they depart the roadway. And more safety measures to reduce crashes and their severity are being developed.

The Federal Highway Administration’s policy and guidance includes performance testing for roadside hardware devices before they’re installed. Formal acceptance of crashworthy devices is our responsibility, and external partners with the highest standards of quality, such as the researchers at the Texas Transportation Institute (TTI) Proving Ground, greatly assist us in that mission. TTI has helped raise the bar of excellence for other researchers. The Institute’s consistently reliable, proactive approach to device testing has helped save thousands of lives, not only in Texas but across the nation.

Our greatest hope is that you never use the safety features installed on roadways. No matter how well we do our jobs, the best way to avoid injury is for you, the individual, to be a consciously competent driver (and passenger). So stay safe, stay alert, and be cautious, especially on two-lane roads. Ultimately, safety is the responsibility of each and every one of us.

# Virtual survey crew ahead:

## Radiometer takes guesswork out of signs, markings for horizontal curves

Consistency is an important principle in roadway safety. It ensures that roadways conform to recommended guidelines and promote safety to drivers. The Texas Transportation Institute (TTI) has developed the Radiometer to help improve consistency on horizontal curves.

“A large percentage of crashes occur on horizontal curves on two-lane highways,” says Paul Carlson, head of TTI’s Operations and Design Division. “So we looked at ways to reduce crashes. TTI has done a lot of research in this area over the years, and we helped the Texas Department of Transportation [TxDOT] develop guidelines for how to sign and mark horizontal curves. The guidelines also help improve consistency across districts.”

The Federal Highway Administration (FHWA) later adopted similar guidelines and incorporated them into the national *Manual on Uniform Traffic Control Devices*. Some of the techniques described in the guidelines require knowing the radius of the horizontal curve. Traditionally, this has required survey crews, and the time and money to field them. The Radiometer does away with the need for a survey crew — again improving safety by not exposing crews to traffic.

“The research project by TTI shows the promise of a new procedure using available GPS [global positioning system] technology to adequately determine an appropriate radius for a horizontal curve and its associated advisory speed as an alternate to the current common method of the ‘ballbank’ indicator,” says Joe Toole, associate administrator of safety with FHWA.

The Radiometer sits on the vehicle’s dashboard and operates at normal traveling speeds. “It records the distance and direction of travel,” says Dick Zimmer, TTI senior research specialist, who developed the device’s hardware and software. “At the end of the curve, it computes the radius of the curve. It also shows the vehicle’s latitude and longitude.”

TTI developed the Radiometer for TxDOT and has provided units to the Minnesota Department of Transportation (Mn/DOT) and a private

“A large percentage of crashes occur on horizontal curves on two-lane highways. So we looked at ways to reduce crashes. TTI has done a lot of research in this area over the years, and we helped the Texas Department of Transportation develop guidelines for how to sign and mark horizontal curves. The guidelines also help improve consistency across districts.”

*Paul Carlson,  
 head of TTI’s Operations  
 and Design Division*

traffic engineering service in Australia (which asked for a metric version). TTI has also developed a software program to provide the same function using a laptop and standard GPS device.

Mn/DOT recently surveyed its districts about use of the Radiometer. “Compared to previous methods to determine curve radius, the Radiometers have proven efficient, reliable, easy to install, easy to use and collect data, and relatively safe for the user,” says Katie Fleming, a Mn/DOT research analyst.

According to Kevin Lavery, co-director of Australia’s Integrated Integrity Pty. Ltd., “The Radiometer is the most efficient instrument available for measuring the radii of highway horizontal curves.”

“An ongoing piece of work is developing an Apple app to work on the iPhone,” says Carlson. “The iPhone has built-in accelerometers and can measure the lateral acceleration in a curve. With this additional information, we can do more than just give the user the radius of the curve. The app is in final stages of testing and is envisioned to replace the ballbank indicator. Using the app and the Radiometer will give agencies new tools to uniformly sign and mark horizontal curves.”

Transportation safety — there’s an app for that! ■



The Radiometer measures the radii of highway curves. The device mounts on a vehicle dashboard and operates at normal traveling speeds.



**MORE INFORMATION**

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# Planning for the Future:

## TTI's Center for Strategic Transportation Solutions

**W**here are we going? How will we get there? These questions aren't just philosophical . . . they're strategic. In February 2009, the Texas Transportation Commission adopted the *2030 Committee Texas Transportation Needs Report*, which was developed by the Texas Transportation Institute and the Center for Transportation Research. The report identifies that Texas will need some \$315 billion to meet its transportation needs for the next 20 years.

Better strategic planning will help streamline our state's approach to meeting those needs. To that end, the Texas Legislature has been calling upon the Texas Transportation Institute (TTI) more often over the past year.

"Leveraging TTI's expertise is one way to meet the challenges of maintaining and enhancing the Texas transportation system," explains Cinde Weatherby, who directs TTI's newly christened Center for Strategic Transportation Solutions (CSTS). "Our job is to provide the state's transportation decision makers with the most accurate, factual information we can as they face these challenges."

Created by the 81st Texas Legislature, CSTS analyzes "big picture" transportation issues and evaluates strategic solutions to address various statewide transportation. Legislators see TTI as an unbiased third party regarding the future of transportation in the Lone Star State. The center has coordinated TTI expert researcher testimony 11 times before eight different committees to date in 2010.

The center's current projects emphasize economic analyses and projections. One of these, conducted for the Texas House Select Committee on Transportation Funding, is trying to answer the question, "What is the cost of not increasing the resources available for transportation projects?"

"You can't start talking about solutions until more people understand the problems," says Weatherby. "Transportation funding, planning and project implementation are complicated issues, particularly for those who aren't engineers or planners."

While the center's primary customer is the Texas Legislature, Weatherby also wants to reach out to other governmental levels in Texas and to other states. "Many of the challenges faced at the state level are the same as those faced by municipal, county or regional officials," she says. Weatherby hopes to make the CSTS website, currently in development, a source for information exchange for communities across the United States.

As a member and advisor on several national transportation committees, Weatherby is able to connect with colleagues nationwide trying to answer the same questions. Exchanging best practices will help Texas and other states share lessons learned at a time when no one can afford to reinvent either the wheel or the road it drives on.

"Our legislators are looking for data, they're looking for advice, and they're looking for answers," says David H. Cain, chair of TTI's Advisory Council and former member of the Texas Legislature.

"When they want to get the information from those who will give it to them in the unvarnished way, the unvarnished truth, they come to TTI." 

"Our legislators are looking for data, they're looking for advice, and they're looking for answers. When they want to get the information from those who will give it to them in the unvarnished way, the unvarnished truth, they come to TTI."

*David H. Cain,  
chair of TTI's Advisory Council  
and former member of the  
Texas Legislature*



### MORE INFORMATION

For more information, please contact Cinde Weatherby at (512) 467-0946 or c-weatherby@ttimail.tamu.edu.

## U.S. State Department Signs Major Contract with TTI

In one of the largest contracts ever awarded to Texas Transportation Institute (TTI), the Crashworthy Structures Program has received a U.S. Department of State Bureau of Diplomatic Security pact that will provide up to \$7 million in work over a five-year period.

The contract calls for TTI to design, analyze and test perimeter security devices. The first project will begin immediately as various vehicles are crashed into an instrumented pier designed to measure the impact of the collisions. Because loads imparted to security devices are largely unknown, the tests will help researchers design future devices.

"This contract solidifies our eight-year relationship with the State Department," says Assistant Agency Director Dean Alberson. "Everyone at the Riverside Campus looks forward to this project, which will be a great opportunity for us and expand the kind of work we've done with the agency."

TTI began work with the State Department and its Bureau of Diplomatic Security in 2002. Since that time, TTI has conducted dozens of tests for the agency intended to increase security for the numerous embassies and other posts around the globe. ■

## Mexican University Signs MOU with TTI

Officials with Mexico's Autonomous University of San Luis Potosi signed a memorandum of understanding (MOU) with the Texas Transportation Institute (TTI) in May. The MOU allows the two parties to collaborate on common research interests and exchange faculty and graduate students. The MOU might also expand TTI work with the Mexican government.

"In Mexico, there is a lack of professionals with transportation backgrounds," says Mario Garcia Valdez, the chancellor of the university, who came to College Station, Texas, for a two-day tour of TTI. "Our intent is to fill the void that exists by starting a transportation program at San Luis Potosi." ■

## Former A&M System Regent Joins TTI Advisory Council



Nye

The Texas Transportation Institute (TTI) has a new and distinguished member of the Institute's Advisory Council, Erle Nye, chairman emeritus of TXU Corp. in Dallas.

Nye joins more than 30 other members of the council, providing advice on transportation issues and trends and supporting TTI research programs and initiatives.

A long-time supporter of TTI and Texas A&M University, Nye served two terms on The Texas A&M University System Board of Regents from 1997 to 2009 and was elected chairman in 2001.

In 2005, Nye was appointed to the Board of The University of Texas Investment Management Company and was elected chair in February 2009. He was appointed chairman of the National Infrastructure Advisory Council by former President George Bush and served on the Advisory Committee to the President's Commission on Critical Infrastructure Protection and on the U.S. Department of Energy's Electric System Reliability Task Force. ■

## TDS Study Unveils 'Perfect Storm' for Teenagers

A Texas Transportation Institute (TTI) study, conducted by TTI's Teens in the Driver (TDS) Seat program, adds to the mounting evidence that cell-phone use while driving, especially at night, can be fatal. Details of the study, examining crash data over a 10-year period, have received national attention.

The study examined the effects of lighting conditions on crashes from 1999 to 2008 in all 50 states, along with the presence of alcohol as a factor in those crashes. The findings suggest something other than alcohol is increasing the nighttime fatal crashes for teen drivers. The most likely reason, researchers say, is the use of cell phones.

"Being on a cell phone behind the wheel impairs our driving ability on three different and essential levels: cognitive, visual and manual," TDS Director Russell Henk said in announcing the results of the study. "When you add the nighttime danger . . . you create the perfect storm. And, that storm is much more severe for teenage drivers, largely because of their lack of driving experience."

In addition to Henk, other speakers at the news conference included high



State Rep. Larry Phillips speaks at a TDS news conference in Austin.

school students involved with TDS and State Rep. Larry Phillips, the vice chairman of the House Transportation Committee.

"Given the challenge we face, we have to change more than laws," Rep. Phillips said at the news conference. "We have to change the way we think about driving. That's what these young leaders are doing — using peer influence to create a driving safety culture among young people. And if they can change the way that young people drive, then it's my hope that the rest of us can do the same." ■



Davenport

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.

## Hawkins, TAMUite Receive Statewide Honors

The Texas A&M University Student Chapter of the Institute of Transportation Engineers (TAMUite) and Gene Hawkins — Department of Civil Engineering associate professor and Texas Transportation Institute research engineer — were the recipients of prestigious awards during the Institute of Transportation Engineers Texas District Summer Meeting in Sugar Land in June.

Hawkins was recognized with the Engineer of the Year Award. “This was a complete surprise,” Hawkins said. “When you look at the list of people who have been given this award, it’s a who’s who in transportation engineering in Texas, and I’m very honored to be included in that company.”

Meanwhile, for the 13th time since 1985, TAMUite was named the 2010 Texas District Outstanding Student Chapter. “We strive to make our organization one through which students can enrich their lives technically, professionally and socially,” Chapter President Kristopher Ball said of the award. As a result of the honor, TAMUite will now be in the running for the 2010 International Student Chapter Award, which it has won five times in its history. ■

## Employees Recognized at Patent Award Ceremony

Texas Transportation Institute employees were honored by The Texas A&M University System Office of Technology Commercialization (OTC) for three patent awards in 2009. Dean Alberson, Roger Bligh, Lance Bullard, Gene Buth and Hayes Ross attended the Patent and Innovation 2010 Awards Luncheon at the Annenberg Presidential Conference Center at the George Bush Presidential Library in April.

The three patents issued by the U.S. Patent and Trademark Office last year were:

- Cable Anchor Bracket — Buth, Bligh, Ross, Bullard and Alberson;
- Cable Guardrail Release System — Alberson, Buth, Bligh and Bullard; and
- Hybrid Energy Absorbing Reusable Terminal — Alberson and Bullard. ■



Texas A&M University System Chancellor Mike McKinney (left) and OTC’s Guy Diedrich (right) flank Lance Bullard, Roger Bligh, Gene Buth and Dean Alberson. Hayes Ross is not pictured.



Gene Hawkins (left) is surprised at the ITE Texas District Summer Meeting when he’s awarded Transportation Engineer of the Year by ITE International Director Gary Thomas.

## Borowiec Elected to Texas Airports Council



Borowiec

Jeff Borowiec, associate research scientist with the Texas Transportation Institute, became the first “non-aviation” board member of the Texas Airports Council when he was elected to the panel this spring. He was nominated to the Texas Airports Council by incoming president John Happ, the director of aviation for Easterwood

Airport. “One of Happ’s main goals is to strengthen aviation education in Texas,” explains Borowiec. “I have also been appointed to the newly formed education committee.”

The Texas Airports Council is the only statewide airport group dedicated to a wide range of aviation activities including airport promotion, legislative efforts and aviation education programs. ■

## TTI’s Global Presence Expands

Two Texas Transportation Institute (TTI) employees helped extend the Institute’s international reach this summer. Research Scientist Juan Villa moved south of the border, and TTI Senior Research Engineer Nadeem Chaudhary took up residence in Qatar. “We want to have a permanent presence in the Persian Gulf,” Chaudhary said of his new job, which began June 14.

Meanwhile, Villa took up residence in Mexico City in July with an office at the Texas A&M University Center there. “In Mexico and Latin America, it’s important for TTI to have a presence,” Villa said. “By being there, we will be able to expand our research with new sponsors.” ■



**»» TEXAS TRANSPORTATION INSTITUTE  
Publications****TECHNICAL REPORTS**

"Analysis and Recommendations on Protecting Waterways from Encroachment," by Joan Mileski, **0-6225-1**, July 30, 2010.

"Bioretention for Stormwater Quality Improvement in Texas: Pilot Experiments," by Ming-Han Li, **0-5949-2**, July 28, 2010.

"Development, Calibration, and Validation of Performance Prediction Models for the Texas M-E Flexible Pavement Design System," by Fujie Zhou, **0-5798-2**, August 13, 2010.

"Development of Decision-Making Support Tools for Early Right-of-Way Acquisitions," by Paul Krugler, **0-5534-2**, May 10, 2010.

"Development of the Texas Revenue Estimator and Needs Determination System (T.R.E.N.D.S.) Model," by David Ellis, **0-6395-TI-1**, May 12, 2010.

"Evaluation of Potential Benefits of Wider and Brighter Edge Line Pavement Markings," by Jeff Miles, **0-5862-1**, August 3, 2010.

"Field and Laboratory Investigation of Warm Mix Asphalt in Texas," by Cindy Estakhri, **0-5597-2**, August 11, 2010.

"Guidelines for the Use of Pavement Marking Symbols at Freeway Interchanges: Final Report," by Brooke Ullman, **0-5890-1**, April 26, 2010.

"Integrating the Transportation System with a University Campus Transportation Master Plan: Best Practices and Lessons Learned," by Rafael Aldrete-Sanchez, **0-6608-3**, May 28, 2010.

"Balanced Mix Design Report for Lufkin's Crack Attenuating Mix (CAM)," by Tom Scullion, **5-5598-01-1**, May 27, 2010.

"Quantifying the Purchasing Power of Public Transportation in Texas: Technical Report," by Linda Cherrington, **0-6194-1**, August 3, 2010.

"Site Specific Wave Parameters for Texas Coastal Bridges: Final Report," by Jun Jin, **0-6063-1**, May 7, 2010.

"Texas Perpetual Pavements: Experience Overview and the Way Forward," by Lubinda Walubita, **0-4822-3**, August 17, 2010.

"Potential Development of an Intercity Passenger Transit System in Texas — Final Project Report," by Curtis Morgan, **0-5930-2**, May 17, 2010.

**PROJECT SUMMARY REPORTS  
AND PRODUCTS**

"Potential Development of an Intercity Passenger Transit System in Texas: GIS Maps," by Curtis Morgan, **0-5930-P2**, April 9, 2010.

"Development of Precast Bridge Deck Overhang System," by David Trejo, **0-6100-S**, May 24, 2010.

"Estimated Impacts of the 2010 Census on the Texas Transit Funding Formula: Project Summary Report," by Linda Cherrington, **0-6199-S**, June 14, 2010.

"Estimated Impacts of the 2010 Census on the Texas Transit Funding Formula: Summary Report on Findings," by Linda Cherrington, **0-6199-P1**, August 11, 2010.

"Existing Regional and Rainfall Factors," by Emmanuel Fernando, **5-4519-01-P1**, August 12, 2010.

"Feasibility and Applications of RFID Technologies to Support Right-of-Way Functions," by Gene Hawkins, **0-6142-S**, June 17, 2010.

"Guidebook on Preserving the Functionality of State Highways in Texas," by Ed Hard, **0-6208-P1**, May 7, 2010.

"A Logical Guideline for Super-Heavy Load Review Policy," by Jeongho Oh, **0-5270-S**, July 23, 2010.

"Methods for Developing External Travel Survey Data," by Steve Farnsworth, **0-6583-S**, June 18, 2010.

"Operational Factors That Impact Truck Use of Toll Roads," by Chris Poe, **0-5377-S**, June 23, 2010.

"Strategies and Recommendations for Integrating Utility and Environmental Processes at TxDOT," by Cesar Quiroga, **0-6065-P1**, May 28, 2010.

"Texas Perpetual Pavements — New Design Guidelines," by Lubinda Walubita, **0-4822-P6**, June 21, 2010.

"TxACOL Workshop — Texas Asphalt Concrete Overlay Design and Analysis System," by Sheng Hu, **5-5123-03-P1**, June 24, 2010.

"Water Retention Techniques for Vegetation Establishment in TxDOT West Texas Regions," by Jett McFalls, **0-5748-S**, May 27, 2010.

**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.