texite Technical Journal

District 9 of the Institute of Transportation Engineers

Volume 51, Number 2 Fall 2005

Technically Speaking...

By Paul Luedtke, Chair, Technical Committee

As an engineering organization, almost everything we do is based on technical analysis - from finding the most accurate traffic counters to finding the best “technical” solution to a roadway alignment or subdivision layout. Not many years ago it would have seemed odd for me to have placed quotes around the word technical in the previous sentence. Thirty years ago there was only the technical answer to most engineers. Many would say we have ‘grown’ since then and I would be one of them. Now we are much better at seeing engineering projects from a wider perspective and it has made us a little easier to get along with and in some cases has enabled us to keep our jobs.

However, with all this in mind, we must always be vigilant for the technical solution. That is our role, even when it isn’t popular. Even though the best transportation engineering technical solution may not be the most beneficial to society as a whole we must still advocate it during the broader deliberations because it is a crucial component in the best overall solution. Sometimes I feel like a defense attorney who must defend someone who they know is guilty. Their job is to make sure they get a fair trial – not necessarily to go free. Likewise, we as technical professionals must advocate the truth of the technical solution so that it gets a ‘fair trial’ – even when we know that in its entirety, it may not be the best overall solution. We must advance and defend the technical solution through healthy debate so that the ultimate solution has every vestige of the technical solution that can reasonably be included and certainly those items that must be included. That is not just our role but our duty as engineers. Only after the final solution is determined can we relax and admire the wisdom of the broader perspective.

Therefore, the technical role of TexITE in our profession is to advance the importance of technical solutions to problems and to enhance and develop the tools and skills necessary to arrive at those technical solutions. A new technical committee has been formed and will be putting together the agenda during the next several months. We will be meeting at least during each TexITE meeting. If you would like to be involved or have ideas for the committee, we would love for you to join us.

I am humbled to be asked to provide the front page article for this newsletter edition, especially when asked to write about the technical role of TexITE in our profession. I hope that these ideas generate some thoughts and conversations for you in your work. Thank you for the opportunity to serve you as Chair of the Technical Committee.

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ITE 2006 Technical Conference and Exhibit - Transportation Solutions for the Real World

March 19-22, 2006

Crowne Plaza Riverwalk
San Antonio, Texas

The PTOE Certification Exam is Coming to Texas!

See Page 20 for more details.

Message from the International Director

By Jim Carvell

Thanks to TexITE Members

This is my final newsletter report as you District 9, TexITE, International Director and it is a little sad for me. I have enjoyed my three year term both in representing you and for the friendships I have made with other ITE International Board members and the ITE staff. I hope I have represented you well. Thank you for giving me this opportunity. I wish my successor, **Robert "Oprah" Wunderlich** well and know he will do an outstanding job.

2005 Annual ITE Meeting

Although this issue of the newsletter has a technical focus, I want to first report on the recent annual meeting in Melbourne, Australia. I was able to use AAdvantage miles for airfare and I wish to thank my previous employers for sending me on those long trips and allowing me to accumulate those miles. And I wish to thank my current employer, Texas Transportation Institute, for its support in allowing me the time to attend nine Board meetings and for financial support in doing so.

We had an excellent meeting and it was well attended by the Australian and New Zealand Sections. However, the attendance from North America was below expectations. I counted six TexITE members in attendance. I do not have final figures, but we no doubt will lose money on this meeting. ITE staff has already begun to look for ways to cut expenses so that our year end losses will be minimized. At the request of myself and others, the fall board meeting will have an agenda item to discuss the wisdom of holding meetings outside North America. It has been policy to do so every ten years. Other items of interest:

- **Earl Newman**, Assistant Director of Public Works, Springfield, Missouri was elected International Vice President. Earl has a good understanding traffic and transportation issues and intends to emphasize ITE's character as a "grass roots" organization. He defeated a very worthy opponent, **Alf Guebert**, of Canada, who I hope will run again.
- This year with electronic balloting, we had the 3rd highest voting percentage (29%) in history. It helped that those who had not voted were sent an electronic reminder. It is estimate that we saved over $10,000 in postage and printing. There is an opportunity for TexITE to use that automated system in the future.
- ITE members can AND SHOULD update their mailing and other information online at ITE.org. Check today to make sure your personal data is correct.
- Two TexITE members were honored with awards from ITE. **Bryan Bochner** received special recognition for his service to the Coordinating Council, and **Connie Dudek** received an award from the Educational Council for innovative approaches in preparing students for their careers. ITE is a volunteer driven organization and the Board would like to give more recognition to the many volunteers that are so necessary to our organization.
- The Board voted to reduce the number of membership grades from 20 to 13. Specific details will be found in an upcoming issue of the ITE Journal. Members will also receive a complimentary membership in one of the

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President's Message

By Connie Clark

The last few years, the Texas Legislature has passed three of what I call 'may declare' speed laws. It started with a 1995 change to Section 545.355 (HB 130). The law was written to help rural counties that do not have the resources for the required traffic engineering studies, to adjust prima facie rural speeds down to appropriate speeds on their rural roads by commissioner court order. Then came SB 540 giving county commissioners the option to declare 'residential street' speed limits as low as 20 mph. Most recently came the HB 87 (79th, Regular Session) which allows city authorities to declare local streets 25 mph if the governing body determines that the prima facie speed limit is 'unreasonable or unsafe' with no specifics as to who or how the safety evaluation would be made. All three of these laws for one reason or another are giving policy makers the opportunity to go around the traffic engineering study and engineering judgment to establish speed limits.

Within our profession we find plenty of research focused on the speed/safety relationship of higher speed highways and arterials, but there is little we can cite that proves that the prima facie 30 mph speed limit is as safe as a posted 20 or 25-mph speed limit. This lack of research in the area is due to many reasons. For example, pedestrian/vehicular collisions on local or residential roads are rare, so before and after crash history is difficult to statistically analyze and to draw decisive conclusions. All we really can say in response to pleas for lower speed limits is that posting a lower speed will not result in overall speed reduction without heavy enforcement.

The number one reason given in the emotional argument for reducing speed limits is for the safety of the children. We sometimes give approval to facilities that do not address the needs

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Legislative Update: A Report on the 79th (2005) State Legislative Session

By Walter Ragsdale, P.E., Chairman-Legislative Committee

In the 79th Legislative Session, a total of 5,369 bills were introduced: 1,397 of these bills were passed and 105 bills specifically related to City functions were passed.

The following describes some of the major events affecting transportation that occurred in the 79th Legislative Session.

- No bills were passed that would prohibit cities from implementing automated enforcement of red light running. Several attempts were made and the House passed H.B. 259 and H.B. 1367. There were several other attempts to get this same language in other transportation bills; however, the Senate defeated all of these attempts (i.e.: 18-15 for H.B. 2702).
- This session's largest transportation bill (H.B. 2702) has been signed by the Governor. It contains many new rules governing regional mobility authorities and the Trans Texas Corridor. Among many other things the bill:
  - ◊ provides that the Texas Department of Transportation (TxDOT) and a public utility shall share equally the cost of the relocation of a utility facility that is made after September 1, 2005 and before September 1, 2007 and that is: (a) required by the improvement of a non-tolled highway to add one or more tolled lanes; (b) required by the improvement of a non-tolled highway that has been converted to a turnpike project or toll project; or (c) required for the construction on a new location of a turnpike project or toll project or the expansion of such a turnpike project or toll project.
  - ◊ grants local voters an opportunity to vote on the conversion of a state highway to a toll road at an election paid for by the affected local government.
  - ◊ prohibits the operation of a "pocket bike" (mini-motorbike) on a public highway, road, street or a bicycle path.
  - ◊ prohibits a judge from granting deferred adjudication to a commercial driver's license holders for a moving violation.
  - ◊ authorizes TxDOT and a public or private entity to contract with an agency of this state or a local government of the services of peace officers employed by the entity to enforce laws related to the regulation and control of vehicular traffic on a state highway and the payment of the proper toll on a toll project.
  - ◊ authorizes a regional tollway authority or regional mobility authority to transfer any of its projects to one or more local governmental entities under certain circumstances.
  - ◊ transfers state regulatory authority over railroads from the Texas Railroad Commission to TxDOT.
  - ◊ authorizes a political subdivision to consent to the use of its property for state highway purposes without the necessity of bidding or other procedures.
  - ◊ authorizes TxDOT to enter into an agreement with a public entity to permit the entity to design, develop, finance, construct, maintain, repair, or operate a toll project.
- Turnpike Projects – H.B. 2650: authorizes a city to enter into an agreement with the Texas Department of Transportation (TxDOT), a private entity, or a regional mobility authority to assist in financing the construction, maintenance, and operation of a turnpike project located in the city's jurisdiction, in return for a percentage of the revenue from the project when the agreement is approved by TxDOT and the revenue is used for transportation purposes.
- The Air Quality Bill (H.B. 2481) extending TERP passed; however, of the approximately $56 million in fees collected on vehicle emission inspections, transportation will receive only $8 million with the remainder going to the general fund.
- TxDOT received a slight increase in funding.
- A diversion of $100 million from Fund 6 (state gas tax) to Rural School Bus Operation.
- The Department of Public Safety continues to be approximately 90% funded by Fund 6 (state gas tax).
- Some of the Texas Mobility funds will be used to balance the State budget.
- A Regional Transit Review Committee was created for the Dallas/Ft. Worth area.
- MPO Policy Board Members will be required to file financial disclosure statements.
- Reverse Pass Through Toll Agreements were authorized.
- A Clean School Bus Program was created.
- A Study Commission on Transportation Financing was created.
- Texas Commission on Environmental Quality is prohibited from banning idling motor vehicles while the driver is on a federally mandated rest period, but drivers may not idle in a school zone.

Announcements

TexITE Technical Committee

The Purpose of the Technical Committee is to focus on the technical issues that are at the heart of Transportation Engineering and to help with the annual Technical Journal, the annual Technical Awards, and the ongoing technical development of TexITE members. Committee members include:

- **Paul Leudtke**, Chair
- **Mark Olson**
- **Srini Sunkari**
- **Tony Voigt**
- **Randy Machemehl**
- **Nada Trout**
- **Carol Lewis**

Anyone interested in becoming a part of this new and exciting endeavor should contact **Paul Leudtke** at PLuedtke@ci.garland.tx.us

Nippon Carbide Industries is on the Move!

Nippon Carbide Industries (USA) Inc., manufacturer of Nikkalite Brand reflective sign, barricade, and commercial graphic films, is pleased to announce the grand opening of their new corporate facility in Santa Fe Springs, California. This facility will have a state of the art distribution center to better meet the supply and demand of their customers. NCI is also pleased to announce the hiring of **Richard Brown** as Southeast Regional Sales Manager, located in Mooresville, North Carolina. For more information about Nikkalite brand products, please contact **Charlie Bond**, Director of Sales in their Carrollton, Texas location at 800-395-2528. The new corporate office change of address is: NPI, 12981 East Florence Avenue, Santa Fe Springs, CA 90670.

"Crystal Grade" Sign Sheeting Product

Charlie Bond, Director of Sales for **Nippon Carbide Industries**, is pleased to announce the availability of their ASTM Type VIII "Crystal Grade" Prismatic Sign Sheeting Product. This traffic sign sheeting has improved visibility for medium to long distance signage. Many municipalities are now utilizing this product for over head mast arm signs and other regulatory signs that need maximum visibility in both day and night conditions. For more information, please contact NCI at 1-800-395-2528 or visit their website at www.nikkalite.com

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Editorial Note: *The Editorial Staff apologizes for not updating the officers list in the Spring 2005 issue of the newsletter.*

Upcoming Conferences

- International Truck and Bus Safety and Security Symposium, Alexandria, Virginia, November 14-16, 2005
- TRB 85th Annual Meeting, Washington, D.C., January 22-26, 2006
- Transportation & Economic Development 2006 (TED2006), Little Rock, Arkansas, March 28-30, 2006
- Tenth National Light Rail Transit Conference: Light Rail, A World of Applications and Opportunities, St. Louis, Missouri, April 9-11, 2006
- North American Travel Monitoring Exposition and Conference (NATMEC), Minneapolis, Minnesota, June 4-7, 2006
- Applications of Advanced Technologies in Transportation, Chicago, Illinois, August 13-16, 2006
- 9th International Conference on Low-Volume Roads, Austin, Texas, June 24-27, 2007

Guidelines for Vehicle Lane Restrictions in Texas

By Darrell W. Borchardt, Deborah L. Jasek, and Andrew J. Ballard

As more operating agencies look for low-cost ways to improve the safety of Texas' urban freeways, a demonstration project on the I-10 East Freeway in Houston used a previously unused law in the state that allows vehicles (18-wheeler trucks in this case) to be restricted from an inside freeway lane (Figure 1).

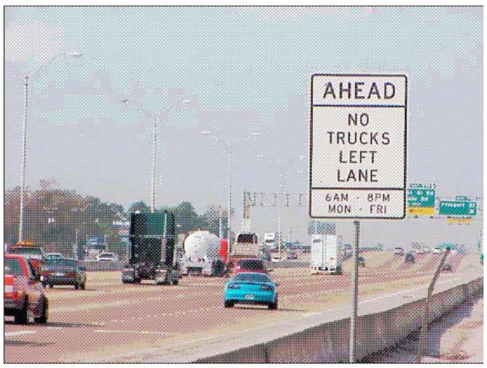

Figure 1. Truck Restriction on I-10 East Freeway in Houston

The project was a success in that a preliminary review indicated that vehicle crashes had been reduced along that section of freeway. As word of this success spread throughout the state, other municipalities wanted to deploy a similar project on their freeways and were anticipating similar successes. However, there had not been a long-term evaluation of the demonstration project and a defined set of guidelines had not been developed.

Texas Department of Transportation (TxDOT) Project 0-4761 was initiated to complete a more detailed evaluation of the vehicle lane restriction concept and to develop a set of guidelines that could be used statewide for implementation on other highways. The 18-month project was structured to develop the guidelines such that the lane restriction could be deployed where warranted, while at the same time not "over-deployed" such that its effectiveness would be reduced.

What We Did...

The project began with a literature review and a profile of views from other states to determine any specific issues relative to lane restrictions for heavy trucks that might apply in Texas. The operational and safety impacts with respect to vehicle lane restrictions within the state were also studied. Existing lane restriction projects in the state were monitored and evaluated throughout the duration of the project, and the effect of enforcement on safety was studied. Researchers developed guidelines for future deployment of vehicle lane restrictions (specific to heavy truck traffic) based upon the findings of this project.

What We Found...

Other states have had similar successes with implementation of similar projects. The I-10 East Freeway project has been operating in Houston since September 2000, and crash rates have decreased by 7 percent throughout the areas included in the project, while the rates have increased by 3 percent on an adjacent section of that freeway without the restriction in place. However, it was inconclusive whether enforcement had any impact upon safety. The compliance on all projects in Houston continues to achieve levels above the goal of 85 percent, indicating that the guidelines used to develop the existing projects do not need a major overhaul and should continue to be used as appropriate. Agencies are encouraged to work together in developing an overall plan should it be determined that restrictions need to be considered, and enforcement is an important component in this process.

The Researchers Recommend ...

Based upon the findings of the research project, researchers developed a set of guidelines that should be used when developing vehicle lane restrictions in Texas:

- The requirements of Texas Transportation Code Section 545.0651 or 545.0652 should be met.
- A minimum of 4 percent total trucks in the traffic stream over a consecutive 24-hour period is necessary.
- Approximately 10 percent of the total truck traffic should be observed using the lane (most likely left or inside) to be restricted.
- The section of freeway to be restricted should be approximately 1 mile beyond any entry and/or exit ramps in the restricted lane to allow sufficient distance for traffic to access or vacate the lane as needed.
- The length of freeway to be restricted should be a minimum length of 6 continuous miles.
- A brief overview of the local freeway system should be completed to develop an overall plan for truck restriction implementation.
- Truck volumes and operations should be monitored such that the guidelines continue to be met. Monitoring also serves as a means to be aware of increasing truck and general traffic volumes, which may also cause concern that the restriction may need to be modified to accommodate higher traffic volumes.
- As compliance is an important element of the restriction, routine enforcement of either regular traffic patrols and/or specialized dedicated units should be available for deployment.
- Signs should be provided at 1-mile intervals throughout the restricted area. In addition to signs placed along the right side of the freeway as per normal practice, supplemental signs should be placed overhead and along the left side to increase awareness of the restriction. The sign message should specify the class of vehicles to which the restrictions apply (for example, "vehicles with three or more axles" instead of "trucks").
- A good public information campaign should be undertaken to inform the public of the implementation of the restriction. Special emphasis on getting the word out to truck drivers who frequent the corridor is important to assure success of the project.

For More Details...

The research is documented in TTI Report 0-4671-1, *Monitoring of Texas Vehicle Lane Restrictions*.

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To obtain copies of reports, contact **Nancy Pippin**, Texas Transportation Institute, TTI Communications, at (979) 458-0481 or n-pippin@ttimail. tamu.edu. See our online catalog at http://tti.tamu.edu.

Practices to Improve the Safety of Mobile and Short Duration Maintenance Operations

Researchers: Melisa D. Finley, P.E., Brooke R. Ullman, P.E., and Nada D. Trout

Maintenance work is often accomplished using mobile or short duration work zones. Mobile operations typically consist of one or more vehicles that move along the road intermittently or continuously at very slow speeds relative to the normal traffic stream. Short duration operations involve work that occupies a location for up to one hour. Both types of operations present challenges with regard to installing traffic control devices. For mobile operations the traffic control devices used to protect workers and motorists need to progress along with the work area. With short duration activities it is sometimes impractical to install a full complement of traffic control devices for a stationary lane closure since it takes longer to set up the devices than to perform the work activity.

Recently, the Texas Transportation Institute (TTI) conducted a two-year research project for the Texas Department of Transportation (TxDOT) to identify and evaluate new traffic control devices and practices that could be used to improve the safety of mobile and short duration maintenance operations. The first year of research project focused on identifying hazards encountered by both workers and motorists in mobile and short duration maintenance operations. To accomplish this objective, researchers conducted a survey of state transportation agencies, held discussion groups with TxDOT maintenance and supervisory personnel, and performed field observations of mobile and short duration operations.

The primary hazards identified were apparent motorist misunderstanding of traffic control devices, vehicles entering the work convoy, speed differential between the normal traffic stream and the work convoy, and passing maneuvers around the work convoy on two-lane, two-way roadways. Researchers concluded that many of these concerns could be addressed by providing motorists with more specific information regarding upcoming conditions and/or the appropriate driving action to take.

During the second year, researchers conducted focus groups, motorist surveys, and a field study to assess motorist comprehension and the operational effectiveness of current and innovative traffic control devices used to inform motorists about:

- the number of vehicles in a work convoy,
- the speed differential between the work convoy and the normal traffic stream,
- passing a work convoy on two-lane, two-way roadways with improved shoulders, and
- the LANE BLOCKED sign.

The results of second-year activities yielded the following findings and recommendations.

- The WORK CONVOY sign (Figure 1a) does not convey to motorists that they are approaching multiple work vehicles. Placing the number of work vehicles on the sign (**Figure 1b**) provides motorists with more specific information and thus improved motorist understanding. Thus, the "#" VEHICLE CONVOY sign should be used instead of the WORK CONVOY sign. The number needs to be adjustable and easy to change.
- Motorists understood that the YOUR SPEED display (**Figure 2a**) was telling them how fast they were traveling. However, this display does not provide information to motorists about the speed differential between themselves and the work vehicle. The MY SPEED display (shows the speed of the work vehicle) and the YOUR SPEED/MY SPEED display (shows the speed of the approaching motorist and the speed of the work vehicle) were not understood by motorists (**Figures 2b and 2c**, respectively). The speed shown on the MY SPEED display was commonly mistaken as the speed the motorist was traveling instead of the speed of the work vehicle. Most motorists could not recall all of the YOUR SPEED/MY SPEED display and thus did not understand the display.
- For mobile operations on two-lane, two-way roadways with improved shoulders, the addition of the message PASS ON SHOULDER improved the comprehension rate but did not improve motorist compliance of passing the work convoy to the right. However, researchers believe that the motorist compliance results may have been impacted by a lack of time to read the PASS ON SHOULDER message prior to initiating the passing maneuver. During the field study, 10-inch letters were used to form the PASS ON SHOULDER message (maximum letter height that could be used when displaying a two-line text message on the truck-mounted changeable message sign used in the field study). Previous research has shown that the legibility distance of a 10.6 inch letter is only 324 ft (10-inch letters would provide even less legibility distance). However, typically motorists traveling between 60 and 70 mph begin the passing maneuver approximately 350 ft upstream of the overtaken vehicle. Thus, researchers hypothesize that motorists had already made their decision to pass the trail vehicle on either the left or right and initiated the passing maneuver prior to be able to read the PASS ON SHOULDER message.
- The LANE BLOCKED sign is understood by motorists and operationally yields a response from motorists similar to a portable changeable message sign (PCMS). The LANE BLOCKED sign should be required on divided highways with four or more lanes in each direction. A PCMS can be substituted for the LANE BLOCKED sign on divided highways with three or less lanes in each

direction. Researchers recommend the use of the PCMS messages shown in **Figure 3** and a minimum letter height of 12 inches.

In addition, with input from an advisory panel comprised of TxDOT personnel and contractors, researchers:

- examined the terminology used to define mobile and short duration operations and recommended changes to the work zone definitions in the *Texas Manual on Uniform Traffic Control Devices* and TxDOT *Traffic Control Plans* to help maintenance personnel better distinguish between the different types of operations,
- developed maintenance traffic control plans for select mobile and short duration operations,
- developed guidance for the use of trail and shadow vehicles for selected operations based on roadway volume (average daily traffic) and posted speed, and
- developed quick reference tables that direct maintenance personnel to the appropriate mobile and short duration practice(s).

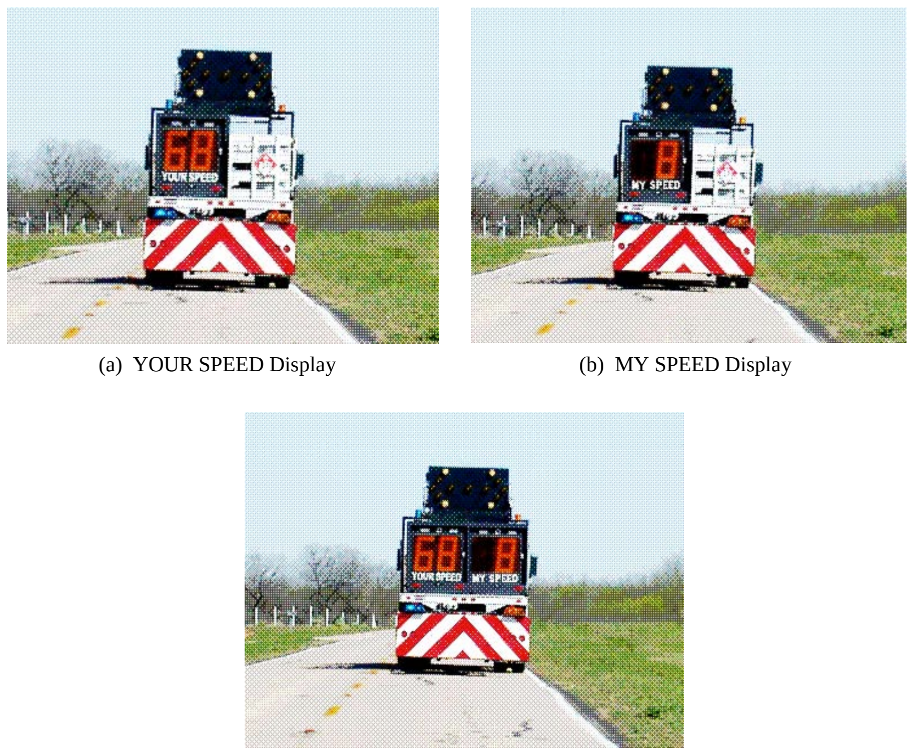
TxDOT has recently allocated funds for an implementation project that will help five TxDOT districts refine and apply the recommended guidelines and best practices with respect to roadways in their area.

The research is documented in the following three reports which can be accessed at http://tti.tamu.edu/product/ (search for "4174"):

- 0-4174-1, *Identification of Hazards Associated with Mobile and Short Duration Work Zones,*
- 0-4174-2, *Traffic Control Devices and Practices to Improve the Safety of Mobile and Short Duration Operations,* and
- 0-4174-S, *Practices to Improve the Safety of Mobile and Short Duration Maintenance Operations.*

(a) WORK CONVOY sign (b) # VEHICLE CONVOY sign

Figure 1. *Current and Modified WORK CONVEY Sign*



(a) YOUR SPEED Display (b) MY SPEED Display

(c) YOUR SPEED/MY SPEED Display

Figure 2. *Speed Displays Evaluated*

LEFT LANE CLOSED	**RIGHT LANE CLOSED**	**CENTER LANE CLOSED**

Figure 3. *Recommended PCMS Messages for Mobile Operations on Divided Highways*

*For more information concerning the implementation project, contact **Gary Tarter**, Texas Department of Transportation, (512) 416-3227, gtarter@dot.state.tx.us. For more information regarding the research project, contact **Melisa D. Finley**, **P.E.**, Texas Transportation Institute, (979) 845-7596, m-finley@tamu.edu.*

Work Zone Crash Influences on Texas Roadways

Authors: Gerald L. Ullman, Ph.D., P.E., Steven D. Schrock, P.E., A. Scott Cothron, Edgar Kraus, and Anthony Voigt, P.E.

Figure 1. *Protecting Both Workers and the Traveling Public in Work Zones is a High TxDOT Priority*

As the caption for Figure 1 indicates, protecting both workers and the traveling public in work zones is a high priority for the Texas Department of Transportation (TxDOT). TxDOT continuously searches for answers concerning what can be done to help reduce the frequency of fatal work zone crashes in Texas. To find such answers, officials need a better understanding of the work zone features and conditions that are associated with fatal work zone crashes.

Unfortunately, traditional police crash report forms do not capture work zone features with the level of detail and consistency needed for a meaningful analysis. Therefore, TxDOT contracted with the Texas Transportation Institute (TTI) to develop a method to obtain detailed work zone information from fatal crash locations, collect and analyze the information, and provide countermeasure recommendations to reduce fatal work zone crashes statewide.

What We Did…

Five TTI researchers from College Station, Arlington, Houston, and San Antonio joined forces to serve as work zone crash site investigators for the duration of the project. Upon notification that a fatal crash had occurred in a work zone, one or more of the researchers would travel to that location and conduct a focused inventory and assessment of the features and conditions at the work zone at the time of the crash. The data were then analyzed to determine relevant trends and identify potential countermeasures that could help reduce the fatal work zone crashes that occur.

Researchers first met with TxDOT officials and with representatives of the Texas Office of the Attorney General to formulate appropriate data collection and analysis protocols. Researchers then

contacted safety coordinators and others in each of the TxDOT districts and requested that they contact the TTI researchers whenever a fatal work zone crash occurred in their jurisdiction. The data collection protocol was pilot tested, and each of the researchers was trained in the protocol to ensure consistent inventories and assessments over time and among the research team members.

The inventory and assessment protocol required researchers to document work type and location, permanent and temporary roadway geometrics, sight distances, and permanent and temporary traffic control signing layout and condition present in the vicinity of the crash. After each investigation, these data were brought back to the office and compared to existing standards such as the *Manual on Uniform Traffic Control Devices (MUTCD).* Researchers also utilized principles of positive guidance to assess the condition of the overall information system presented to drivers traversing the work zone.

For each work zone assessed, researchers strove to develop an understanding of the likely chain-of-events leading up to and through the crash. Researchers also attempted to assess what work zone features, if any, may have had any direct or indirect influences upon the chain-of-events. For purposes of this project, influence was defined as anything that — if removed — may have somehow altered the chain-of-events that led to the crash in the first place. Some examples are shown in Table 1 of the types of direct and indirect work zone influences on the hypothesized chain-of-events assessed during the project.

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Table 1. *Examples of Direct and Indirect Work Zone Influences on Crash Chain-of-Events*

Types of Work Zone Influences	Specific Examples Identified
Direct	• Pavement edge drop-off is higher than currently allowed in standards • Signing and channelization are misaligned enough to potentially create travel path confusion for the driver • Horizontal alignment is designed for speeds significantly lower than upstream operating speed of traffic
Indirect	• Temporary two-lane, two-way operations on a previous four-lane divided facility create a more difficult crossing condition for a jaywalking pedestrian • Elimination of emergency shoulders requires stalled vehicle to remain in active travel lane until removal • Temporary lane closures create traffic queues that are not normally expected or likely on the facility at that time of day (or night) • Dust from construction activities temporarily reduces driver visibility • Loss of edge line delineation at night during repaving operations eliminates a source of control and guidance information otherwise available to drivers • Loss of continuous shoulder rumble strip protection (when previously present) during repaving operations eliminates a warning system otherwise available to drivers • Wrong-way vehicles intrude into a work area from the unexpected direction and surprise oncoming traffic and the work crew

Dynamic Message Signs – Past, Present and Future

By Jessica Hernandez (Presented at the Summer 2005 TexITE Meeting, Laredo, Texas, June 2005)

Dynamic Message Signs (DMS), also known as Variable Message Signs (VMS), have been increasingly deployed across the nation because of their versatile applications for traffic information provision, traffic and emergency management, and even public safety (i.e. amber alerts). One of the primary uses of DMS is to warn motorists of unstable traffic conditions or special events so that motorists are alert and prepared to take certain courses of action.

Due to the broad range of information that can be provided by DMS, measuring the impact of DMS on highway traffic has been a vague and challenging issue, and the 'true' benefit and impact of DMS continues to be an enigma with ongoing debate to many researchers and practitioners. How will the sign "CONGESTION AHEAD, EXPECT DELAY" affect traffic? Will motorists divert from the freeway when they see the sign "ACCIDENT ON FREEWAY, LEFT LANE CLOSED"? Will drivers have the same reaction to congestion signs? What if a congestion sign re-appears daily during the peak hours, will motorists become impervious and eventually ignore such a message?

These are the questions that many engineers speculate and have yet to find consistently convincing evidence to lead to the verdict as situations providing contradicting answers to the above questions constantly occur at different times and/or locations. The evidence either proving or disproving the correlation between the sign message and resultant traffic pattern is important for those who attempt to categorize and select DMS messages according to traffic related principles and anticipate reasonable outcomes. However, until now, such evidence does not exist.

It is sometimes questioned why traffic management agencies and the traveling public have high hopes, and continue investing in DMS while very little knowledge about the effectiveness of DMS has been systematically articulated and documented. Attempting to understand or measure the effect of DMS on highway traffic should not be considered a futile exercise although it is indeed extremely difficult because many Traffic Management Centers (TMCs) do not have a systematic and consistent way of categorizing DMS messages.

Limited in scope but somehow meaningful and useful insights may be derived from a rigorous research approach, which includes clear and specific evaluation of goals, careful selection of appropriate methods, collection of necessary data needed by the evaluation method, and logical interpretation of testing results.

Central to this research is to infer the influence of DMS on traffic diversion and the magnitude of diversion during peak and off-peak hours subsequent to a highway incident by focusing on two aspects: (1) whether traffic exhibits recurrent weekly patter and (2) whether DMS cause higher traffic diversion and magnitude. Due to the specifically defined research goal and modeling approach, this research only aims at combining a few pieces of the massive puzzle by examining cross-referencing evidence for behavior-oriented research and insights for practical highway traffic operations.

San Antonio was chosen as the study site because of TransGuide's sophisticated database allowing researchers to access all available interstate highway traffic data in quasi real time. Several considerations were taken into account when selecting the study areas. The site selection criteria included: good availability of ramp and mainlane loop detector data, DMS in close upstream proximity, and a good number of incidents downstream. The location first location was selected was upon suggestion from **Mr. David Hernandez** from the Texas Department of Transportation San Antonio district and the subsequent locations were selected based on the high number of accident messages displayed at said locations.

The key contribution of this research is the thoroughness of the data collection. It was decided to focus on existing traffic data to account for the actions taken by drivers, to eliminate any discrepancies that may occur from driver statements concerning what they have done or will do in a given situation. Therefore, upon location selection, the DMS message data was extracted. The DMS message logs show the time at which each message is displayed, thus allowing for the messages to be matched to the traffic data. It is important to note that travel time messages and non-traffic related messages were grouped into the "no sign" conditions.

Extracted lane data included traffic volumes and speed on the mainlane (downstream of the off ramp gore) and ramp traffic volumes. Both the off-peak (2:00 - 4:00 PM) and peak (5:00 - 7:00 PM) traffic data in 20-second intervals was extracted for all four locations and analyzed in one-minute aggregated intervals.

This research uses statistical testing techniques to address the aforementioned research questions. That is to say, it is not attempted to unveil individual motorist's internal decision mechanisms; instead, the concern lies with aggregated traffic patterns resulting from the interaction of motorists and DMS messages. The fundamental rationale for this approach is that if DMS induce a substantial effect on individual motorist's diversion decision, this effect should then be reflected on the collective traffic flows with significant characteristics that can be captured in statistical testing. In order to arrive at an unbiased and meaningful conclusion, appropriate data extraction and testing procedures have been designed.

Separate analyses were conducted for the afternoon peak and off-peak hours as traffic patterns could be highly different during these two time periods.

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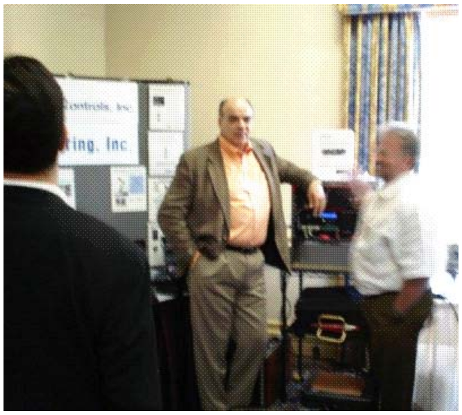
Summer Meeting 2005 - Laredo, Texas

Vendors Reception Kicks Off the Laredo Meeting in Style



Upcoming Meeting

The 2006 TexITE Winter Meeting will be held in conjunction with the
ITE 2006 Technical Conference and Exhibit

March 19-22, 2006

Crowne Plaza Riverwalk
San Antonio, Texas

Summer Meeting 2005 - Laredo, Texas

Colleagues, Comestibles, Confabulations: TexITE Enjoys Laredo

Section News & Activities

Brazos Valley Section

The Brazos Valley Section will host the 2006 Summer TexITE meeting. Dates for the meeting are June 8-10, 2006. **Srini Sunkari** will be serving as the local arrangements chair.

Capital Area Section

The June 3, 2005 meeting of the Capital Area Section was held at the PBS&J office. At the beginning of the meeting, **Brian Van de Walle** discussed the possibility of hosting a PTOE exam on October 22, 2005. The section voted to sponsor the exam and underwrite the cost of not meeting the minimum number of test takers.

After the PTOE discussion, **Lucy Galbraith** with Capital Metro presented information on the “All System Go Plan” and “Transit-Oriented Development.” In her discussion about the “All Systems Go Plan,” she discussed the many services it will provide and timeframes. The plan included expanding the Express Bus Routes, creating Rapid Bus Routes with traffic signal priority, develop and implement the starter Urban Commuter Rail Service, connecting Circulator Services to the rail stations, and the Regional Commuter Rail Service.

The last part of Lucy’s presentation was about Transit-Oriented Developments. She discussed the vision of these developments having retail, office, residential, and open space adjacent to the Commuter Rail stations.

Upcoming section meeting dates are October 7 and December 2, 2005. The Section is looking for meeting locations, so if you would like to volunteer your office for a meeting, please contact **Sharon Barta** at sbarta@dot.state.tx.us. Please also submit any suggestions for meeting topics and speakers.

Greater Dallas Section

The Greater Dallas Section holds meetings on the second Thursday of each month. You can find information about their upcoming meetings at: http://www.texite.org/dallas/maindallas.htm.

Greater Fort Worth Section

The Section typically meets on the third Thursday of each month at Joe T. Garcia's in Fort Worth for a noon hour meeting providing conversation, networking and a technical presentation. Speakers at our meetings come from a wide range of entities including governmental, academics/research, and consultants, to name a few. Check out the website for more details: www.texite.org/fortworth/mainfortworth.htm.

Greater Houston Section

The next meeting of the Greater Houston Section will be held on October 12. The speaker will be D. **Jesse Hegemier, P.E.**, Fort Bend County Engineer. On November 9, **Dale Rudick** will be presenting on transportation projects and issues in the City of Sugar Land. Register online at http://www.texite.org/houston/mainhouston.htm

Make plans to attend the TexITE Houston Area Shrimp Boil! It will be held on October 29, 2005 at Spring Creek Park.

Planning has begun for the 2007 Winter TexITE State Meeting to be held in Houston. Hotel locations are currently being sought; more details will come later, so stay tuned.

South Texas Section

You can find section meeting information at this website: http://www.texite.org/southtexas/index.htm.

People News

Greater Dallas Section

Walter P. Moore announces that **Srinivas M. Sangineni, P.E.**, has joined the firm as Senior Associate and Managing Director, Traffic/ITS Services in the Dallas Infrastructure office. An expert in transportation analysis, advanced arterial traffic management, traffic signal timing and simulation software, Sangineni brings significant experience in innovative traffic engineering and intelligent transportation system solutions throughout Texas.

Also new to Walter P. Moore is Graduate Engineer **Siddhartha Sinha, EIT**, who will be working on various traffic studies and plans.

Collin County Commissioner **Jack Hatchell**, Precinct 4, was recently awarded the prestigious Road Hand Award. Originated in 1973, the Road Hand Award recognizes Texas' major transportation advocates. Each year, district engineers nominate individuals for induction into the Hall of Honor. TxDOT's executive director makes the final selection. “What a wonderful surprise,” says Commissioner Hatchell. “It is very special to be honored by my peers in engineering.” Commissioner Hatchell has served as president of the North Central Texas Council of Governments and is currently chair of the Regional Transportation Council.

Jacobs is pleased to announce that **Walter Ragsdale** recently joined their Dallas office, bringing with him 28 years of experience in the transportation planning, traffic engineering and ITS areas. He brings with him a wealth of knowledge from the public sector, having worked at the City of Richardson, and having been involved in addressing transportation issues all around the Dallas-Fort Worth region through his involvement with the North Central Texas Council of Governments.

Jacobs is pleased to announce that **Asif Khan** recently received his Texas Professional Engineer's license. Asif has been helping the Dallas office of Jacobs in traffic signal design, signing/pavement marking design, microscopic simulation, traffic projections and traffic impact studies.

Greater Houston Section

(Continued from page 12)

Congratulations to **Sean Merrell** for passing his PE exam in June! Sean is working on some traffic signal designs and signal timing projects for TxDOT. He works for Brown & Gay Engineers, Inc. Sean and his wife, Liz, are also expecting their first child in September.

Project News

Greater Dallas Section

Jacobs and the **City of Plano** recently submitted final plans on improvements along the US 75 corridor in Plano. These improvements to intersections, ramps and frontage roads between President George Bush Turnpike and Spring Creek Parkway will relieve congestion in one of the regions busiest commercial corridors.

Jacobs, in conjunction with the North **Central Texas Council of Governments**, the **City of Dallas**, **Dallas Area Rapid Transit**, and **Dallas County**, prepared a Comprehensive Transportation Plan for the Dallas Central Business District. The plan's recommendations included a classification system for the downtown streets, street improvements, pedestrian improvements, and a corridor for a new light rail line. In conjunction with the plan, Jacobs developed a VISSIM microscopic simulation model of the entire downtown area, which allowed the analysis of interactions between the vehicles, trains and pedestrians.

Student News

Texas A&M University

Texas A&M senior, **Geoffrey Chum, EIT**, was awarded ITE's Burton W. Marsh Fellowship for Graduate Study in Traffic and Transportation Engineering. The fellowship was established in 1989 to encourage outstanding civil engineering students to pursue graduate studies in traffic/transportation engineering. Geoffrey will graduate with his B.S. from Texas A&M in December and is looking forward to pursuing his graduate studies in January 2006.

Texas Southern University

The members of Texas Southern University's student ITE chapter spent the summer engaged in research and educational opportunities that are an important component of their Master's level program.

During the summer, **Kenneth Brown**, TSU ITE President, was assigned to the Maritime sector of the US Department of Transportation in Washington, DC. His work focused on the vulnerability of the Marine transportation system to terrorist attacks. Through his research, he hoped to bring to the forefront the major issues faced by the shipping industry, to promote a sense of awareness to its fragility. His efforts included a thorough investigation of incidents in the shipping industry and the effect on the economy, and the enhancement of the current Maritime website, providing users with a comprehensive collection of information in a user friendly manner.

Blain McKenzie, TSU ITE International Student Network Committee Chair, worked on graduate research at TSU, focusing on emissions/air quality testing and analysis with respect to transportation.

(Continued on page 21)

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Active Advance Warning Devices Show Promise for School Bus Zone Safety

By J. L. Carson, A. Holick, E. S. Park, M. Wooldridge, and R. Zimmer

The findings contained in this report respond to the three part problem described below:

1. Children are at greatest risk when in school bus loading or unloading zones. Students are three to four times more likely to be killed while boarding or leaving the bus than while riding the bus.
2. Efforts to improve safety at school bus loading or unloading zones have been focused on increasing school bus conspicuity and enhancing driver guidance. However, none of these efforts are effective (i.e., visible from a distance) if a school bus is stopped in an area of limited visibility.
3. The constant display of the static warning message, SCHOOL BUS STOP AHEAD, combined with the limited presence of the hazard (i.e., the stopped school bus and children), results in rapid motorist desensitization to the risk and a subsequent degradation in safety at school bus loading and unloading zones.

The primary objective of this research project was twofold:

1. to develop an active advance warning device (AAWD) comprising an actuated flashing beacon supplement to a conventional SCHOOL BUS STOP AHEAD (S3-1) sign and
2. to evaluate its effect on driver performance (i.e., reduced speeds, improved vehicle braking activity, reduced erratic maneuvers, etc.) and safety through school bus loading and unloading zones.

Secondary objectives were to summarize AAWD components and costs, develop an activation strategy for the flashing beacon system component, review the liability risk associated with AAWDs (i.e., moving from passive to active warning), review national experience related to AAWDs, and provide guidance regarding potential AAWD specifications and use in Texas.

What We Did…

The AAWD system for use at limited visibility school bus loading and unloading zones was developed to meet state and federal design standards with respect to size, color, illumination rate, etc. The activation system for the flashing beacon component of the AAWD was determined after a critical review of various mechanisms (see Figure 1).

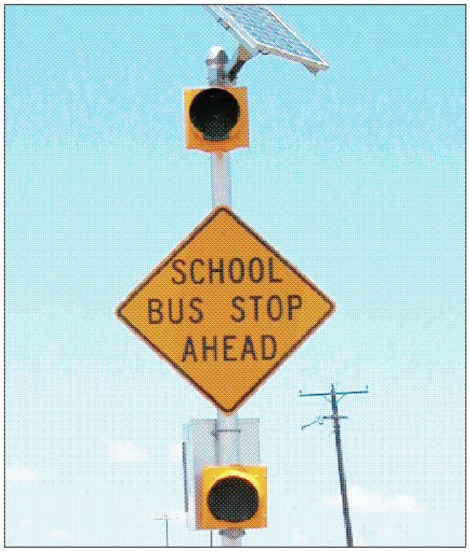

Figure 1. *AAWD System Developed for School Bus Zones*

Concurrent with the development of the AAWD system, a review of both published literature and historic case law was conducted to determine potential additional liability risks associated with generally moving from a passive to an active warning device. Case law information was derived from courts in all 50 states using the LexisNexis Legal Research database.

Along with a review of national experience, several field studies in Texas investigated the effects of AAWDs on driver behavior and safety at school bus loading and unloading zones with limited visibility. In general, sites for this investigation were selected with the following characteristics in mind (see Figure 2):

- limited visibility,
- high speed,
- rural environment,
- reasonably high traffic volumes, and
- "simple" environment without distracting stimuli.

Investigations such as this are challenged by external factors (i.e., increased enforcement presence) and the novelty of the experimental device, which may exaggerate the observed effects of the traffic control device under study. To control for these potential errors, this project used a before/after, case/control experiment. Four case sites and two control sites were observed.

What We Found…

Safety Impacts

Of the 46 published studies reviewed, 37 reported a positive effect (i.e., either a reduction in vehicular speed or a reduction in accidents) resulting from the introduction of AAWDs comprising flashing warning beacons as the, or one of the, system components.

Findings from the local field studies conducted in Texas suggest generally favorable results:

- When considering changes in average vehicle approach speeds measured at both the SCHOOL BUS STOP AHEAD sign and 500 feet upstream of the sign, a statistically significant reduction in average approach speeds was observed (1.0 mph and 2.02 mph respectively) when the flashing beacon was activated.
- Three out of four sites experienced statistically significant speed reductions ranging from 1.18 mph to 3.18 mph when the flashing beacon was activated.
- When a school bus was present at the loading and unloading zone, a statistically significant reduction in vehicle approach speeds was observed (8.62 mph) across all sites at the SCHOOL BUS STOP AHEAD sign when the flashing beacon was activated.
- One out of four sites experienced a statistically significant reduction in average approach speeds (15.08 mph) measured at the SCHOOL BUS STOP

Figure 2. *Sample Site for AAWD Experiment*

AHEAD sign with a bus present at the loading and unloading zone and with the flashing beacon activated.

It is likely that further statistically significant favorable results are precluded by the small sample sizes, particularly when AAWD performance at individual sites is examined. Brake light actuation distances were largely unaffected by the activation of the flashing beacon.

System Components and Costs
The system components for the prototype AAWD developed and tested as part of this project included a SCHOOL BUS STOP AHEAD advance warning sign (S3-1), top- and bottom-mounted flashing beacons, and a flashing beacon activation system. Costs for the final system are estimated to be $2,000 for the S3-1 sign and flashing beacons and $2,600 for the flashing beacon activation system; a single flashing beacon activation system can be used with multiple S3-1 sign and flashing beacon assemblies. These estimates do not include sign installation or ongoing maintenance and operations costs.

Liability Risk
Based on a review of published literature and a review of historic case law, the addition of flashing beacons to the SCHOOL BUS STOP AHEAD (S3-1) sign appears to pose minimal additional liability risk above what is already experienced by transportation departments. With respect to general warning sign use, transportation departments are largely protected from tort liability through discretionary immunity and are further protected by following:

1. state or federal standards and specifications for installations and operations,
2. a logical and systematic decision-making process for selecting appropriate warning devices,
3. a logical and systematic decision-making process for operating active warning devices, and
4. a program of regular inspection and maintenance for warning devices.

Areas of potential liability risk, though not prevalent in the historic case law to date, relate to a transportation department's "jurisdictional responsibility" with respect to establishing, operating, and maintaining school bus loading and unloading zones and the expectation or lack of expectation of a hazard tied to the activation of the flashing beacon (i.e., motorists may rely solely on the flashing beacons as their indication of the hazard [i.e., school bus and children] and may not exercise the same degree of caution when the bus is not present and the beacons are not flashing but children are nonetheless present at the bus stop).

The Researchers Recommend…

Given the generally favorable safety-related impacts (both nationally and locally), the low system cost, and the minimal additional liability risk incurred beyond that of a general warning sign, the active advance warning device system comprising a SCHOOL BUS STOP AHEAD sign (S3-1), flashing beacons, and a flashing beacon activation system is recommended for implementation. Prior to or in conjunction with this implementation, researchers recommend the following activities to ensure that the safety of children and the motoring public is maximized and the Texas Department of Transportation is protected from tort liability:

- Incorporate the AAWD into state standards and specifications.
- Develop a logical and systematic decision-making process for selecting school bus loading and unloading zones equipped with the supplemental flashing beacons (vs. those that are unsigned or signed only with static SCHOOL BUS STOP AHEAD signs).
- Develop a logical and systematic decision-making process for operating the active flashing beacon system component.
- Develop a program of regular inspection and maintenance for the AAWD that includes the general condition of the sign and the functionality of the flashing beacon system component.
- Define the department's "jurisdictional responsibility" with respect to establishing, operating, and maintaining school bus loading and unloading zones.
- Investigate additional or modified signing (i.e., a supplemental plaque) to reflect the presence of children even if the flashing beacons are not activated.

(Continued on page 19)

Two-Way Frontage Road Treatments to Reduce Wrong-Way Movements

By S.T. Chrylser and S.D. Schrock

This research effort focuses on the use of lane direction pavement marking arrows as a means of providing an additional cue for drivers to recognize the direction of traffic flow.

Previous Lane Use Arrow Research

Pavement markings provide one of the clues that drivers can use to identify the proper direction of traffic flow for a lane. The use of yellow for separating opposing traffic on two-way roadways and as the left edge line on one-way roadways has been well established for over a quarter of a century. A recent National Cooperative Highway Research Project (NCHRP) study evaluated the potential for replacing the yellow-white marking system with an all-white one (1). The primary focus of the researchers for that effort was a survey of over 800 drivers to assess driver understanding of the existing yellow-white and potential all-white marking systems. These survey results have been described in previous papers (1). The researchers studied one potential method for improving driver understanding of traffic direction without relying upon pavement marking color. This question asked drivers to describe the meaning of arrows located in the traffic lane.

Lane direction arrows are described in the Manual on Uniform Traffic Control Devices for Streets and Highways (2). In the U.S., they are commonly used on approaches to intersections to indicate permitted movements from each lane. They are also commonly used in Europe at intersections and other junctions where there is the potential for wrong-way movements. Figure 1 shows a graphic used in the NCHRP study. As had been used in other questions of this survey, the pavement markings used in this image were black to avoid the use of color to indicate lane direction.

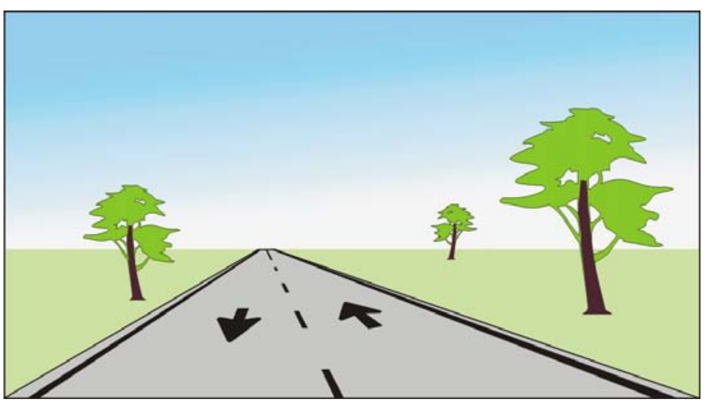

Figure 1. *Graphic for Lane Direction Arrow Survey Question.*

A correct response was provided by 93.7 percent of the survey participants. Only 4.3 percent provided an incorrect response or no response. A questionable response was given by 2.1 percent of the survey participants. The responses to this question indicate a very high level of inherent understanding associated with the lane direction arrows. Such arrows might have significant value in locations where drivers may be confused as to the direction of traffic flow.

Opportunity for Further Research

A field evaluation of the effectiveness of the lane direction arrows was not a part of the scope of the NCHRP all-white pavement marking project. However, the results were so positive that TTI researchers believed that opportunity existed to expand on this for this research project. Members of the TTI research team were aware of a location in the College Station, Texas, area with anecdotal evidence of wrong-way movements on a two-way frontage road. The roadway appeared to be a natural location for assessing the potential effectiveness of the lane direction arrows.

Field Evaluation

In Texas many freeways exit onto adjacent frontage roads from which drivers access adjacent properties and cross streets. Use of the frontage road system is widespread in Texas and it is common for urban frontage roads to operate as one-way roadways, while rural areas tend to have two-way frontage roads. The presence of both one-way and two-way frontage roads in a given area may create increased potential for wrong-way movements on the two-way frontage roads. The location selected for the field evaluation was such a location. It is a short section of two-way frontage road on the fringe of the College Station, Texas, urban area.

An example of a wrong-way maneuver could include selecting the oncoming lane of a two-way frontage road, as shown in Figure 2. This site was selected because it was believed to have several advantages for this research. It is located at the edge of the Bryan/College Station urban area where the majority of the freeway exit ramps merge into one-way frontage roads, so unfamiliar drivers may be less likely to expect a two-way frontage road at this location. Additionally, traffic volumes are low, especially for traffic traveling in the opposite direction on the frontage road, meaning that drivers could not rely upon the presence of other vehicles to indicate traffic direction. Also, the regional airport is located at this exit and most of the exiting traffic is traveling to the airport. This traffic has to make a left turn at the downstream intersection. Drivers unaware of the two-way traffic flow would be more likely to stay in the left lane approaching the intersection. Existing pavement markings were in fair condition at the time of the study, and could be seen both during the day and at night. Additionally, there was an existing two-way traffic warning sign (W6-3) to the right of the frontage road at the ramp terminus.

The pavement marking treatment that was selected for research was a pair of standard 9 ft white retroreflective thermoplastic pavement marking defined in the MUTCD as a “Through Lane-Use Arrow” (2). However, as they are not being used in the immediate vicinity of an intersection they are referred to in this research as lane direction arrows.

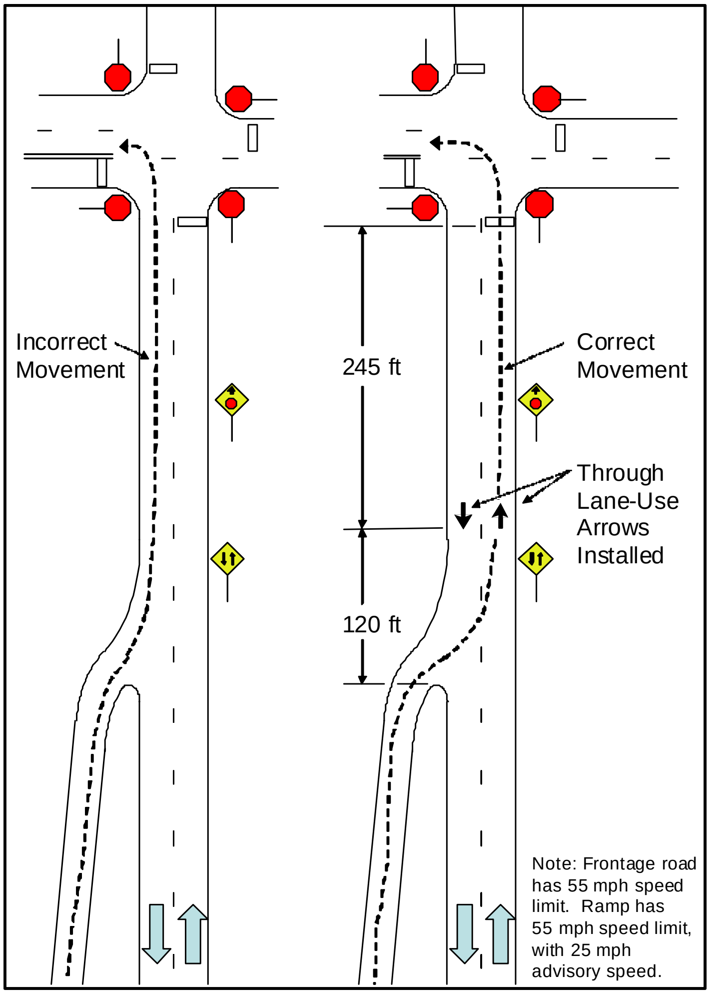

Figure 2. Possible Wrong-Way Driving Maneuver and Countermeasure Installation.

These were placed approximately 120 ft away from the gore area of the exit ramp, one in each lane of travel. This was determined to be close enough to the ramp terminus that drivers would be able to see the arrows as they reached the frontage road, but not so close that a driver choosing the correct right-hand lane would have to drive over the arrow in the left oncoming lane. Typical cost for such an installation is in the range of $300.

Data Collection and Reduction Procedures

Data were collected using a portable video trailer from March 1-8, 2004, and again on June 4-11. The videotapes were then viewed by TTI staff to determine the lane choice and the direction taken by each vehicle as it left the exit ramp. A conservative designation was made for each vehicle whether the driver made a proper maneuver or not. If the driver drove in the left lane for any time (other than properly crossing the lane at the end of the exit ramp to access the right-hand lane) it was considered a wrong maneuver. Additionally, conflicts that occurred between two or more vehicles were also recorded.

Results of Field Installation

Statistical tests were performed between the before and after

Figure 3. View of Frontage Road Location after Arrow Installation

periods showed that the presence of the lane direction arrows had a very beneficial effect on the proportion of wrong-way driving maneuvers. There were significant reductions in the overall proportion of drivers that selected the left (incorrect) lane after entering the frontage road from the freeway exit. Overall, incorrect maneuvers were reduced from 7.4 percent to 0.7 percent, a 90-percent reduction of the rate. Stated another way, prior to the installation of the lane direction arrows about one out of every thirteen vehicles that exited the freeway at this location ended up driving in the wrong frontage road lane. After the installation of the arrows, this dropped to about one out of every 150 vehicles.

The impact was even greater for the vehicles that turned left at the intersection toward the airport. Prior to the arrow installation, 11.5 percent of vehicles remained in the left (incorrect) lane, but after the installation only 0.9 percent remained in the incorrect lane, or a reduction of 93 percent of wrong-way maneuvers. So in the before case about one out of eight vehicles that were heading to the airport made an incorrect maneuver, while after the installation this had dropped to about one out of 117 vehicles. There were no apparent changes in the driving environment in the study area other than the arrow installation that could have explained a change in this behavior of drivers.

The analysis also found that there was no statistically significant difference between the rates of wrong-way movements when compared by lighting conditions (day and night). Therefore researchers concluded that the presence of the lane direction arrows were equally effective both during the day and at night.

The observations of actual conflicts were also analyzed. During the period of data collection prior to the installation of the pavement markings there were 21 observed conflicts involving two vehicles. Seventeen of these conflicts consisted of two left-turning vehicles that came to the frontage road from the exit ramp arriving at the intersection at the same time but in different lanes – one in the correct right lane, one in the incorrect left lane. These vehicles then had to jockey for position after beginning their left turn in order to avoid a crash. In the after period the total conflicts

(Continued on page 19)

Work Zone Crash (Continued from page 8)

It is important to note that influences as defined in this project do not necessarily imply crash causation. Generally speaking, though, direct work zone influences tended to be conditions that may have not completely conformed to existing standards or guidelines. Conversely, indirect influences were those conditions that were compliant from the standpoint of current standards and guidelines, but which still could be seen as influencing either the likelihood or the consequences of the crash chain-of-events.

As the number of work zone assessments performed during the project grew, researchers began to consolidate them into similar chain-of-event "scenarios" as a way of uncovering useful trends. These scenarios then served as the basis for identifying possible countermeasures to mitigate work zone crashes.

What We Found…

Over a 15-month period, researchers investigated 77 fatal work zone crash locations. As might be expected, many crashes that occur within a work zone do not appear to be in any way directly or indirectly influenced by the presence of the work zone itself. As shown in Figure 2, nearly one-half of the crashes investigated (45 percent) fell into the "no-work-zone-influence" category. In comparison, only 8 percent of the crashes in the crash chain-of-events were judged to have had a "direct work zone influence," while another 4 percent of the crashes occurred during work zone traffic control set-up or removal. (Set-up and removal crashes were examined separately because it was not immediately apparent whether such crashes should be considered affected by direct or indirect work zone influences.)

Perhaps most important was the finding that 39 percent of the crashes were judged to have an "indirect work zone influence" associated with them. Obviously, from TxDOT's perspective, countermeasures that address these various indirect work zone influences would be expected to have a significant impact on safety.

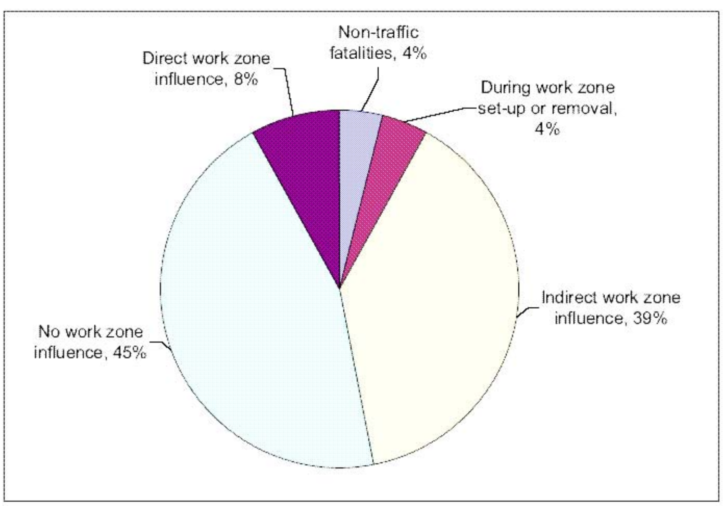

Figure 2. *Work Zone Influence on Crash Chain-of-Events*

The Researchers Recommend…

Emphasizing the crashes where indirect work zone influences were identified in the chain-of-events, researchers brainstormed and critiqued numerous potential crash countermeasures. From the initial list, researchers have presented eight final countermeasures for TxDOT consideration and adoption. These recommendations are as follows:

- Encourage flaggers to have audible warning devices (i.e., horns) with them at flagger stations to warn the work crew of an out-of-control vehicle that they have been unable to stop which is about to encroach into the activity area.
- Encourage additional research into panic-button-type safety clothing to be worn by all workers to warn each other of out-of-control vehicles that may encroach upon the activity area.
- Consider experimentation and eventual implementation of a highly mobile barrier system for short-term work zone activity areas, such as is currently under development in California.
- Consider requiring the use of channelizing devices to continuously delineate roadway edges at night when rumble strips and/or edge line pavement markings are removed or missing temporarily due to pavement resurfacing or replacement.
- Require that a mobile work operation being performed on a paved shoulder switch to the traffic control required for a mobile operation moving in an active travel lane whenever encroaching into the travel lane (such as at shoulder drops at bridges).
- Consider requiring exits or break-down refuge areas be made available at regular intervals (2 miles or less) in work zones where both shoulders are removed for construction.
- At work zones where the direction of travel is changed temporarily in one or more lanes (i.e., a four-lane facility that is converted to two-lane, two-way operation), encourage the use of opposing lane dividers or lane use arrow pavement markings to reinforce the fact that the travel direction for the lane has changed.
- Discourage traffic control plan designs that include transition areas for the work zone on an existing horizontal curve, and encourage that the transition be accomplished on a tangent section instead.

For More Details...

The research results, recommendations, and operating guidelines are documented in Report 0-4028-1, *An Analysis of Fatal Work Zone Crashes in Texas*.

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Dynamic Message Signs (Continued from page 9)

First, the hypothesis was established and tested that traffic exhibits recurrent patterns at the same location during the same period across the selected dates. Only after confirming the existence of the recurrent pattern at the study sites, there was sufficient confidence that observed changes of diversion rates were less likely to be caused by random traffic fluctuations. Coefficient of variance of sample variance was used as the primary indicator for discussion.

Second, for the four studied locations, average diversion rates were tested for those days with signs versus those without. The most frequent messages that appeared on the DMS signs at the selected locations consisted of travel time and messages depicting either congestion or accidents downstream of the DMS location. Considering that messages depicting congested conditions might have a different effect on diversion than messages depicting an accident, they were tested separately. Thus, using the *t*-test, diversion rate was tested for the days depicting either accident or congestion versus those without any signs.

Based on the research findings, it is suggested that individual locations have their own characteristics and alternative routes are an aspect with implications on DMS planning and operations since knowledge of the local area is also a factor in diversion. If a driver is within close range of their destination and a message is encountered, then willingness to divert might increase if the driver is familiar with or aware of possible alternate routes. However, if the driver is relatively far from the destination and is unfamiliar with the local area, then they will be less likely to divert and will have to continue on their pre-selected route.

This research concludes that no evidence exists that DMS bring forth compelling influence on traffic flow re-distribution, which is the aggregated representation of individual motorist's route choice. While mixed results were found at different locations, each location exhibited rather consistent patterns; implying that other site-specific factors (e.g. alternative routes, land use and trip purposes) and other traveler information sources (e.g. radio, traveler information website etc.) are playing a substantial role in the diversion decision making process. Such attributes are difficult to precisely characterize and are typically omitted in most prior studies. However, the findings suggest that rigorous studies into this aspect are needed to further understand the decision making process and resultant traffic patterns related to DMS operations.

Given the fact that traffic re-distribution may be subject to an array of variables, the decision on whether DMS should be installed and the actual installation location should not be based solely on the high expectation that DMS will always help improve traffic under congested or incident situations. More research is needed in order to understand the contributions of DMS from a traffic management perspective; nonetheless, other emerging functional features (e.g. special events, amber alert) may need to be incorporated into the benefit/cost analysis of overall planning and operation of DMS.

Active Advanced Warning Devices (Continued from page 15)

- Periodically evaluate driver behavior at the AAWD sites to ensure that driver desensitization to the warning has not compromised the safety of the site.

If proven to be successful in Texas, this type of AAWD would be easily transferable for application in other states.

For More Details...

The research is documented in Report 0-4749-1, *Development and Evaluation of an Active Warning Device for School Bus Loading and Unloading Points in Areas of Limited Visibility*.

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Two-Way Frontage Roads (Continued from page 17)

was reduced to a single instance of such a double left turn. Clearly, it appears consistent that the absolute reduction of wrong-way driving movements would correspond with a reduction of wrong-way driving-related conflicts. However, the number of conflicts that were observed were virtually eliminated in the data collection period following the installation of the pavement markings, and were statistically significant.

Recommendations

This research provides an indication of the potential effectiveness of low-cost traffic control improvements such as lane direction arrows to improve safety at locations where wrong-way driving occurs. The field evaluation was not of sufficient depth to justify immediate widespread implementation of lane direction arrows. However, the overwhelming reduction in wrong-way driving indicates that the treatment can have a very beneficial safety influence on traffic at locations where drivers may be confused about an appropriate lane selection. To that end, the researchers recommend transportation officials consider this treatment at problem locations.

References

1. Parham, A.H., H.G. Hawkins, Jr., and K.N. Womack. Driver Understanding of Pavement Marking Colors and Patterns. In Transportation Research Record 1844, Transportation Research Board, Washington, D.C. 2003.

This excerpt was taken from: Chrylser, S.T. and S.D. Schrock. Field Evaluations and Driver Comprehension Studies of Horizontal Signing. Report No. FHWA/TX-05/0-4471-2. Texas Transportation Institute, College Station, Texas, February 2005.

Message from Int'l Director (Continued from page 2)

thirteen technical councils.

- The mid-year ITE technical conference will be held in San Antonio March 19-22, 2006. The focus of the meeting is Transportation Solutions for the Real World. My predecessor, **Wayne Kurfees**, and I have pushed to get the mid-year meetings to venues other than the left and right coasts and I hope the San Antonio meeting will be well attended by TexITE members. TexITE will hold its winter meeting in conjunction with the Technical Conference.

Technical Opportunities

I encourage you to visit the ITE home page (http://ite.org/) to see the many opportunities for increasing your technical expertise and competence. If you have specific subjects you would like to have added to the offerings, please let me or an ITE staff member know.

- ITE Councils. There are eleven "area of practice" councils that cover a broad range of transportation topics. You can learn from them and you can contribute your technical talents in shaping policies and practices. http://ite.org/councils/
- CD-ROM. ITE now offers nine professional development program courses on CD-ROM, two in Spanish: These courses would be an excellent program for a section meeting, for individual study, or for use in your company or agency.
  - ◊ Traffic Signal Change Intervals
  - ◊ MUTCD 2000 and 2003 Revisions
  - ◊ Engineering Intersections to Reduce Red-Light Running
  - ◊ Managing High Technology Projects in Transportation
  - ◊ Introduction to Systems Engineering
  - ◊ Intervalos de Despeje de Transito
  - ◊ Fundamentals of Road Weather Management
  - ◊ Ingenieria en Intersecciones para Reducir la Incidencia de Pasarse la Luz Roja
- On-Line Learning. The Institute of Transportation Engineers, with its partner in education, DeakinPrime USA, offers affordable, convenient learning opportunities for transportation professionals that can be accessed from office or home computers. Check http://ite.org/education/OLGcatalog.pdf for more information.
- Web Seminars (Webinars). Despite the cute name, these seminars offer an excellent opportunity for individual or group learning. They are web broadcasts taught by a real live instructor with opportunity for interaction between the instructor and the student. The offerings are expanding but right now the courses offered are Signal Timing, PTOE Refresher Course, and Pedestrian Accessibility. See http://www.ite.org/education/webinars.asp for more information.

As always, feel free to contact me on any ITE issue. It is a pleasure to serve as your representative to the ITE International Board of Direction. And once again, thank you for the opportunity to serve as your international director.

Jim Carvell
jcarvell@tamu.edu.

PTOE Certification

Upcoming Professional Traffic Operations Engineer (PTOE) examination dates in Texas are as follows:

- **Saturday, October 22, 2005**
  Austin, TX
- **Saturday, March 11, 2006**
  San Antonio, TX

A refresher course will be offered on September 17, 2005 in Austin, Texas. The cost for the course is expected to be $25 to $30 and light refreshments will be provided. If you are a PTOE and are interested in helping out at the refresher course, please contact Brian Van de Walle at (512) 418-4500 or at brian.vandewalle@kimley-horn.com. Registration and location details for the refresher course will be posted on the TexITE webpage, www.texite.org.

Application forms to sit for the PTOE exam must be received at least 30 days prior to the exam date. For applications and additional information about the exam, please visit http://www.ite.org/certification/.

President's Message (Continued from page 2)

of users other than the motor vehicle, when we know by all evidence that the safest measure on all streets for school children is a good walking and bicycling environment. Traffic engineers are seen as interested only in traffic flow without consideration for safety. We know that is not the case, that safety is first. So, perhaps we should be trying to help our elected officials respond to concerned citizens and residents with a look at other more effective safety measures that can or should be incorporated into roadway design.

I do not know the answer, but I believe that a new dialogue may need to begin with decision makers for a better solution before there are more of these 'may declare' laws enacted that further erode the authority of our traffic engineering judgment and the basic speed law.

-30-
C Clark
8/29/05

Student News *(Continued from page 13)*

This project tested emissions from several light-duty vehicles in a pre-determined, residential area under various testing scenarios. The automobiles varied in age, mileage, make, and model. Blain's findings showed that left-turn movements produced higher emission levels than right-turn movements. Blain submitted the results of his research in a paper to be presented at the 2006 Meeting of the Transportation Research Board (TRB).

Hao Lio, TSU ITE Webmaster, worked on a Southwest Region University Transportation Center (SWUTC) sponsored project, "Intelligent Transportation System Data Compression Using Advanced Signal Processing Techniques." In this project, advanced signal procession techniques (e.g. Wavelet Transformation) were used to decompose and compress the ITS data set. These signals were subsequently recovered by adequate reconstruction algorithms. Finally computer software coded in MATLAB was developed with the suitable Graphic User Interfaces (GUI) designed. The results were submitted to TRB for presentation at their annual meeting.

Mrs. Amma Cobbinah, TSU ITE Secretary, spent her summer with Houston METRO working on several projects including organization and analysis of HOV Data, accident analysis, hot spots evaluation, and incident response. She also assisted in studies of delay time, towing trends, and statistical data summaries. Her work included bus focused data assessments including an analysis of schedule deviation and protocol. This information was gathered for each of METRO's more than 100 bus routes. Bus on-time performance was compiled and evaluated according to trip details, block summary, and headway deviation. She also performed an evaluation of bus trip times by driving times.

Job Postings

The City of Lawton, OK (Pop. 93,000) has the following opening: CIVIL ENGINEER (Traffic) – Hiring salary range - $58,868 - $63,393 Annually (DOQ) – Degree in civil engineering or closely related field and a minimum of two years professional civil engineering experience with municipal infrastructure improvements or closely related experience. Registration in Oklahoma as a Professional Engineer or the ability to obtain registration in Oklahoma by reciprocity within six months. Must submit copy of college transcript with application. (*Civil Engineer, Traffic* – Specific duties: Administers various traffic engineering contracts for the City to include contract preparation, development of technical requirements, and time frames. Detailed information and application may be obtained from the City of Lawton, Human Resources Department, 1405 SW Eleventh Street, Lawton, OK 73501. Phone: (580) 581-3392. Fax: (580) 581-3530. Website: www.cityof.lawton.ok.us. Women and minorities encouraged to apply. EEO/Drug Screen.

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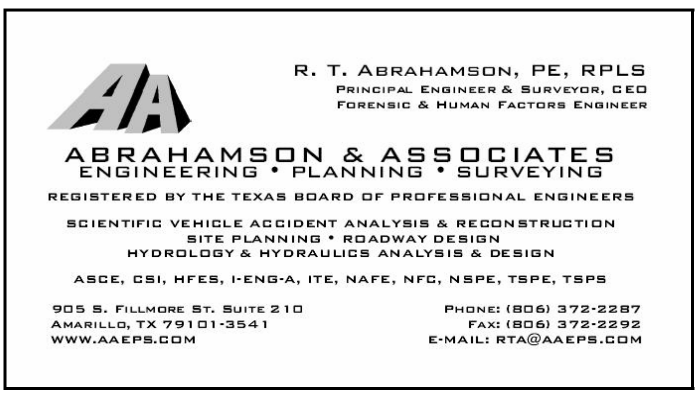

To submit job postings or list your firm in the Professional Services Directory, please contact dena.jackson@rsandh.com


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