Background, Current and Future Opportunities For Transportation-related Interdisciplinary Research

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Summary of recent research projects funded by TxDOT

- 9 transportation research projects funded by TxDOT from 2006 to 2010
- The major collaborators include:
  - The Center for Transportation Research (The University of Texas at Austin)
  - Texas Transportation Institute (Texas A&M, College Station)
Summary of research areas:

- The research areas include:
  - **construction and maintenance** (multiple construction and maintenance fields including geotechnical considerations, materials and pavements, construction management, safety, environmental design, crash testing, computer simulation.)
  - **traffic safety and human performance** (safety, security, emergency evacuation (hurricane evacuation), accident characteristics, driver behavior, young and old driver safety, teen drivers, alcohol impact, night visibility, accident statistics, safety equipment, driving simulation)
  - **operations and traffic management** (highway and street traffic operations and signal control, congestion reduction, high occupancy vehicle lanes, toll roads, access control, speed control, work zone traffic control device, computer simulation)
  - **intelligent transportation systems** (real time traveler information systems, on-board navigation system, demand responsive signal control, smart work zone, automatic speed detection and enforcement, red light running detection and enforcement, traffic and congestion detector, signal optimization and coordination, telecommunication, simulation)
Project 1

- **Title:** Utilizing the Data Collected at Traffic Management Centers for Planning Purposes through Non-Traditional Sources and Improved Equipment (Project o-5686) (ITS)
- **Sponsor:** Texas Department of Transportation
- **Peer Reviewed (Y/N):** Yes
- **Date:** 2006-2008
- **Total Amount:** $267,834
- **Role:** Co-Principle Investigator with UT-Austin
Traffic information center

Leased line (above 2400bps)

Real-time signal control depending on the traffic volume
Project 2

- **Title:** In-Service Evaluation of Cable Median Barrier Performance (Project 0-5609) (safety)
- **Sponsor:** Texas Department of Transportation
- **Peer Reviewed (Y/N):** Yes
- **Date:** 2006-2008
- **Total Amount:** $198,516
- **Role:** Co-Principle Investigator with TTI
Project 3

- **Title:** Updated Work Zone Capacities (Project 0-5619) *(maintenance, operations)*
- **Sponsor:** Texas Department of Transportation
- **Peer Reviewed (Y/N):** Yes
- **Date:** 2006-2008
- **Total Amount:** $237,873
- **Role:** Co-Principle Investigator with TTI
Project 4

- **Title:** Feasibility of Speed Harmonization and Peak Period Shoulder Use to Manage Urban Freeway Congestion (Project 0-5913) *(Operation, ITS)*
- **Sponsor:** Texas Department of Transportation
- **Peer Reviewed (Y/N):** Yes
- **Date:** 2007-2009
- **Total Amount:** $267,001
- **Role:** Co-Principle Investigator with UT-Austin
Project 5

• **Title:** Improved Positive Protection Guidance for Work Zones (Project 0-6163) (safety, maintenance)

• **Sponsor:** Texas Department of Transportation

• **Peer Reviewed (Y/N):** Yes

• **Date:** 2008-2010

• **Total Amount:** $ 298,576

• **Role:** Co-Principle Investigator with TTI
Project 6

- **Title:** Assessment of Need and Feasibility of Truck-Mounted Changeable Message Sings for Scheduled and Unscheduled Operations (0-6167) (Operations, ITS)
- **Sponsor:** Texas Department of Transportation
- **Peer Reviewed (Y/N):** Yes
- **Date:** 2008-2010
- **Total Amount:** $ 209,270
- **Role:** Principle Investigator with TTI
IS SAFETY YOUR PRIORITY?

WORKERS ON ROAD

CAUTION BUMP AHEAD

FRESH OIL AHEAD

ROAD WORK AHEAD

SLOW

R135
Teampall
Mhaighreidh
St. MARGARET'S
Bede Blainseir
BLANCHARDSTOWN
Project 7

- **Title:** Development of Guidelines for Implementation of Roundabouts in Texas (Project 0-6414) (design)
- **Sponsor:** Texas Department of Transportation
- **Peer Reviewed (Y/N):** Yes
- **Date:** 2009-2011
- **Total Amount:** $281,558
- **Role:** Co-Principle Investigator with UT
Project 8

- **Title:** Safety Implications of Using Active Traffic Strategies on TxDOT Freeways (Project 0-6576) (ITS, safety)
- **Sponsor:** Texas Department of Transportation
- **Peer Reviewed (Y/N):** Yes
- **Date:** 2009-2011
- **Total Amount:** $ 278,435
- **Role:** Co-Principle Investigator with UT
Project 9

- **Title:** Development of a Performance Measurement Based Methodology to Objectively Compare Operation Improvements with Capacity Additions (Project o-6487) (operations, ITS, planning)
- **Sponsor:** Texas Department of Transportation
- **Peer Reviewed (Y/N):** Yes
- **Date:** 2009-2011
- **Total Amount:** $304,889
- **Role:** Co-Principle Investigator with UT
<table>
<thead>
<tr>
<th><strong>Table 1: List of Common Operational Strategies</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Speed Advisories &amp; Harmonization</strong></td>
</tr>
<tr>
<td><strong>Ramp Treatments: Metering &amp; Closure</strong></td>
</tr>
<tr>
<td><strong>Roadway Pricing: Static &amp; Variable, Cordon Tolls, HOT lanes</strong></td>
</tr>
<tr>
<td><strong>Managed Lanes</strong></td>
</tr>
<tr>
<td>• HOV &amp; HOT Lanes</td>
</tr>
<tr>
<td>• Shoulder Lane Usage</td>
</tr>
<tr>
<td>• Reversible Lanes</td>
</tr>
<tr>
<td>• Access-Controlled Lanes</td>
</tr>
<tr>
<td>• Pedestrian &amp; Cyclist Access Provisions</td>
</tr>
<tr>
<td>• Bus Access &amp; Transit-only Lanes</td>
</tr>
<tr>
<td><strong>Signalization</strong></td>
</tr>
<tr>
<td>• Demand-responsive, Adaptive &amp; Coordinated</td>
</tr>
<tr>
<td>• Signal Pre-emption</td>
</tr>
<tr>
<td>• Pedestrian Accommodation</td>
</tr>
<tr>
<td><strong>Intelligent Transportation Systems (ITS) &amp; Traffic Management Center (TMC) Operations</strong></td>
</tr>
<tr>
<td>• Real-time Data Collection for System Performance Monitoring, Long-run Management, Advanced Traveler Information Systems (ATIS) &amp; Incident Anticipation</td>
</tr>
<tr>
<td>• ATIS via Dynamic Message Signs, In-vehicle Devices, &amp; Radio Advisories</td>
</tr>
<tr>
<td><strong>Incident Management (e.g., roving service patrols)</strong></td>
</tr>
<tr>
<td><strong>Workzone Policies (speed limits, barrier designs, scheduling, signage)</strong></td>
</tr>
<tr>
<td><strong>Transit Operations (e.g., scheduling and routing)</strong></td>
</tr>
</tbody>
</table>
More research details about TxDOT project 0-6167

The TxDOT project is about “Assessment of Need and Feasibility of Truck-Mounted Changeable Message Signs (TMCMS) for Scheduled and Unscheduled Operations”

During this research, we developed “A Microscopic Simulation-Based Decision Support System to Develop Changeable Message Sign Alternatives for Highway Work Zones”, as a part of the final research report, and paper published in IEEE Proceedings of Intelligent Transportation Systems.
1. Introduction

- Changeable Message Signs are basically used to give motorists real-time traffic safety and guidance information about scheduled and unscheduled events that significantly impact traffic on the highway system.
- The use of the changeable message signs in various transportation activities like construction and maintenance zones has become more popular and effective in the recent years.
1. Introduction (cont.)

- There are some guidelines about how to choose different displayed message for engineers;
- However, human factor studies are still needed to determine the effectiveness of different messages displayed to motorists, i.e. comprehension and preference of the messages, which may vary from person to person.
1. Introduction (cont.)

- Both microscopic computer simulation and driving simulator methods have been applied.
- The advantages of simulation-based models include risk-freeness to experiment and test assumptions, a means to predict by allowing preview of all possible scenarios.
- Microscopic computer simulation allows for a large and significant amount of high-quality data that can be collected quickly in the laboratory or any location with the minimal imposition to the motoring public, who agree to participate in the study.
2. Objectives

- Develop a web-based decision support system to facilitate human factor studies for the use of changeable message signs (CMS) with the support of microscopic computer simulation.
3. Development of Decision Support System (DSS)

- The process of DSS development includes four steps:
  - Development of Message Alternatives through Telephone/Online Surveys
  - Determine Possible Work Zone Scenarios
  - Simulate Work Zone Scenarios through VISSIM Simulation
  - Apply Simulation Videos/Images for Human Factor Study
3.1. Development of Message Alternatives through Telephone/Online Surveys

- The research team has collected 130 copies of telephone and online interviews from 42 States, among which 16 interviews are from Texas.
- Out of the total surveys completed from different districts of TxDOT and other State DOTs, it is learnt that the 42 percent of the interviewees have some experience of using TMCMS for different operations.
Survey Distribution
3.2 Determine Work Zone Scenarios

- A list of simulation scenarios consists of 16 scenarios with the consideration of following situations:
  1. Urban vs. rural roads;
  2. Two lanes vs. multiple lanes;
  3. Stationary vs. mobile operations.
  4. Truck-mounted CMS vs. traditional message signs.
- There are 3 kinds of message alternatives for each scenario.
- The sample message alternatives for right lane closed scenario in urban area as below:
## Sample Message Alternatives

<table>
<thead>
<tr>
<th>Symbol</th>
<th>RGT LN CLSD</th>
<th>RIGHT LANE CLOSED</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Symbol" /></td>
<td>RGT LN CLSD</td>
<td>RIGHT LANE CLOSED</td>
</tr>
</tbody>
</table>

![Image](image)
3.3 Development of Scenarios through VISSIM Simulations

- V3DM module of VISSIM is used to create working trucks and truck mounted with CMS, because the existing microscopic traffic simulation doesn’t have the TMCMS function.
# Images of TMCMS and Working Truck

<table>
<thead>
<tr>
<th>TMCMS</th>
<th>Working truck</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="TMCMS Image" /></td>
<td><img src="image2.png" alt="Working Truck Image" /></td>
</tr>
</tbody>
</table>

Note: Images show the TMCMS and working truck with reflective safety features.
3.3 Simulate Work Zone Scenarios through VISSIM Simulation

- The mobile work zone scenario consists of some maintenance vehicles moving in the front of the TMCMS at the design speed of 5 mph in the work zone. The design speed for other traveling vehicles is 30 mph.
- Urban featured background module is applied and following are the sample image and video.
Sample Image in Right Lane Closed Case
RIGHT LANE CLOSED
3.4. Human Factor Study Using the Simulated Videos/Images

- Design of Web-based decision support system
System User Interface

Welcome:

Changeable Message Signs Alternatives for Multiple Lane Highway

Introduction: Please answer the following questions.

Start!

<table>
<thead>
<tr>
<th>A. SYMBOL</th>
<th>Show Video</th>
<th>Show Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. RGT LN CLSD</td>
<td>Show Video</td>
<td>Show Picture</td>
</tr>
<tr>
<td>C. RIGHT LANE CLOSED</td>
<td>Show Video</td>
<td>Show Picture</td>
</tr>
</tbody>
</table>

Preference
3.4.1 Design of decision support system

- The participants will be asked to answer a few questions and submit their response to the database.
- The evaluation part is focusing on the questions regarding the visibility and comprehension for each message alternative.
- After users input their comments for those questions, the next step is about “preference” where they will decide their preference for those messages.
Sample User Interface with Videos

(1) Symbol({arrow left})
(2) RGT LN CLSD
(3) RIGHT LANE CLOSED
## Sample Questions

<table>
<thead>
<tr>
<th>Question Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1). For the Message:</td>
</tr>
<tr>
<td>2). For the Message “Rgt Ln Clsd”</td>
</tr>
<tr>
<td>3). For the Message “Right Lane Closed”</td>
</tr>
<tr>
<td>4). Preference</td>
</tr>
</tbody>
</table>
4. Data Collection

- A total of 160 surveys were recorded in the database. Each interviewee rated the different messages/symbols.
- For symbol (left arrow) message, majority of the interviewees rated the best, compared to “RIGHT LANE CLOSED”.

## Survey Analysis

<table>
<thead>
<tr>
<th>Message/Graphic</th>
<th>RIGHT LANE CLOSED</th>
<th>RGT LN CLSD</th>
<th>Arrow</th>
<th>Slow down</th>
<th>Debris in road</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Image</strong></td>
<td><strong>RIGHT LANE CLOSED</strong></td>
<td><strong>RGT LN CLSD</strong></td>
<td><strong>ARROW</strong></td>
<td><strong>SLOW DOWN</strong></td>
<td><strong>DEBRIS IN ROAD</strong></td>
</tr>
<tr>
<td><strong>Total No. of Response</strong></td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
<td>160</td>
</tr>
<tr>
<td><strong>Percentage of Rankings</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>31.25%</td>
<td>27.50%</td>
<td>88.75%</td>
<td>41.88%</td>
<td>31.25%</td>
</tr>
<tr>
<td>2</td>
<td>46.25%</td>
<td>60.63%</td>
<td>8.75%</td>
<td>39.38%</td>
<td>8.13%</td>
</tr>
<tr>
<td>3</td>
<td>15.63%</td>
<td>8.75%</td>
<td>0.63%</td>
<td>6.25%</td>
<td>45.00%</td>
</tr>
<tr>
<td>4</td>
<td>6.88%</td>
<td>3.13%</td>
<td>1.88%</td>
<td>12.50%</td>
<td>15.63%</td>
</tr>
<tr>
<td><strong>Weighted Average</strong></td>
<td>1.98125</td>
<td>1.875</td>
<td>1.15625</td>
<td>1.89375</td>
<td>2.45</td>
</tr>
</tbody>
</table>
Future Interdisciplinary Research?

- Sustainable transportation systems (sustainable planning, sustainable materials, sustainable environment (environmental impact))?
- Intelligent Transportation Systems (Traffic operations, information, control, communication, optimization, simulation)?
- Traffic Safety and Security (emergency response, hurricane evacuation, accident statistics, human factor study)?
Potential sponsors?

- Texas Department of Transportation
- U.S. Department of Transportation
- Federal Highway Administration
- National Cooperative Highway Research Program (NCHRP)
- Port or Airport Authorities
gained through extensive successful experience in relevant problem areas. Any agency interested in submitting a proposal or response should first make a frank, thorough self-appraisal to determine whether or not it possesses the capability and experience necessary to ensure successful completion of the project.

Request for proposals and information are published periodically throughout the year by TRB’s various programs. You should check this site frequently to identify new projects that have entered the request-for-proposal phase. In addition, notices are included at appropriate times of the year in TRB’s Transportation Research E-Newsletter. You are encouraged to subscribe to the E-Newsletter. Finally, e-mail notices on RFPs and RFIs are sent out to subscribers of appropriate CRP listservs. Information on becoming a member of one of TRB’s CRP listservs is available on CRP’s information for Proposers page online.

<table>
<thead>
<tr>
<th>Project Number</th>
<th>Project Title</th>
<th>Posted Date</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCHRP 03-100</td>
<td>Evaluating the Performance of Corridors with Roundabouts</td>
<td>9/10/2010</td>
<td>10/26/2010</td>
</tr>
<tr>
<td>NCHRP 07-17</td>
<td>Pedestrian and Bicycle Transportation along Existing Roads</td>
<td>9/1/2010</td>
<td>1/2/2010</td>
</tr>
<tr>
<td>NCHRP 08-36C</td>
<td>Research for the AASHTO Standing Committee on Planning</td>
<td>3/8/2010</td>
<td>9/18/2010</td>
</tr>
<tr>
<td>NCHRP 08-81</td>
<td>Improving the Quality of Motorcycle Travel Data Collection</td>
<td>9/22/2010</td>
<td>11/10/2010</td>
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<tr>
<td>NCHRP 08-82</td>
<td>Deployment, Use, and Effect of Real-Time Traveler Information Systems</td>
<td>9/2/2010</td>
<td>1/2/2010</td>
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<tr>
<td>NCHRP 08-83</td>
<td>Analytical Travel Forecasting Approaches for Project-Level Planning and Design</td>
<td>8/10/2010</td>
<td>9/30/2010</td>
</tr>
<tr>
<td>NCHRP 08-84</td>
<td>Long-Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models</td>
<td>8/20/2010</td>
<td>10/19/2010</td>
</tr>
<tr>
<td>NCHRP 08-85</td>
<td>The Comprehensive Costs of Highway-Rail At-Grade Crossing Crashes</td>
<td>8/20/2010</td>
<td>1/19/2010</td>
</tr>
<tr>
<td>NCHRP 10-05</td>
<td>A Guidebook for Construction Manager-at-Risk Contracting for Highway Projects</td>
<td>9/14/2010</td>
<td>1/13/2010</td>
</tr>
</tbody>
</table>