TRAFFIC CONTROL DEVICE RESEARCH PROGRAM SUMMARY

by

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INTRODUCTION

Traffic control devices provide one of the primary means of communicating vital information to road users. Traffic control devices notify road users of regulations and provide warning and guidance needed for the safe, uniform, and efficient operation of all elements of the traffic stream. Unlike many other elements of the surface transportation system (such as construction activities, structures, geometric alignment, and pavement structures), the service life of traffic control devices is relatively short (typically anywhere from 2 to 12 years). This shorter life increases the relative turnover of devices and presents increased opportunity for implementing research findings. The shorter life creates the opportunity for incorporating material and technology improvements at more frequent intervals. Also, the capital cost of traffic control devices is usually less than that of these other elements. Research on traffic control devices can be (but is not always) less expensive than research on other infrastructure elements of the system because of the lower capital costs of the devices. The traditional Texas Department of Transportation (TxDOT) research program planning cycle requires about a year to plan a research project and at least a year to conduct and report the results (often two or more years). With respect to traffic control devices, this type of program is best suited to addressing longer-range traffic control device issues where an implementation decision can wait two or more years for the research results.

As a result of these factors (smaller scope, shorter service life, lower capital costs, and the typical research program planning cycle), some traffic control device research needs are not addressed in a traditional research program because they do not justify being addressed in a stand-alone project that addresses only one issue. This research project was created to address shorter-term, lower-cost traffic control device research needs that would not be addressed as part of a larger research project.

ACTIVITIES

The project conducted 17 traffic control device related activities during the five-year study. These activities can be grouped into three general categories: those involving field evaluations of traffic control devices, those that developed traffic control device guidelines, and those that were preliminary or theoretical assessments of traffic control device issues. Each project activity is summarized below for each of the categories.

Field Evaluations of Traffic Control Device Performance

The optimal means of assessing the effectiveness of a traffic control device is to evaluate its performance in the field or in a simulated field application. Eight of the activities conducted as part of this project involved some form of field evaluation of the effectiveness of a traffic control device or a related issue.

Assessment of Dual Logos for Specific Services Signs

In 2003, the Texas legislature revised a bill to allow dual logos for both same service (i.e., a restaurant that contains two brands/restaurants) and mixed service (i.e., a facility that provides both gas and food brands/businesses) in specific service signing ("logo signs"). Dual logo panels provide the ability to show a logo for both businesses in a single panel. In this activity, researchers conducted a driver survey to assess driver understanding and response to logo signs. The survey was administered to 205 subjects using a laptop computer. Exposure to logo signs was timed and subjects were asked to indicate whether a specific service was located in the sign they were shown. The results indicate that single logos were correctly recognized more often than dual logos, but that the difference decreased as exposure time increased. The research results did not indicate a need to prohibit dual logos. The researchers did recommend specific limitations on the use of dual logos. Dual logos were incorporated into the 2006 Texas MUTCD. At the national level, the Notice of Proposed Amendments to the 2003 National MUTCD also included a provision for the use of dual logos.

Rear-Facing School Speed Limit Beacons

Flashing beacons are often used with School Speed Limit assemblies to provide an active means of indicating a reduced speed limit in the vicinity of a school. The flashing beacons are visible to a driver approaching the school speed zone. The limitation of this treatment is that, once within the school zone, there are no active reminders of the reduced speed limit. In this activity, the researchers evaluated the impact of a treatment to reduce vehicular speeds within a school speed limit zone. The treatment was a rear-facing beacon on school speed limit assemblies that faced drivers that were still within the school zone. As installed, the rear-facing beacon appeared on the left side of the road and the flashing beacon reminded drivers within the school zone that the reduced speed was in effect. The treatment was found to have a beneficial effect on driver compliance with school speed limits, particularly at sites where a Stop sign or traffic signal was located within the school speed limit zone. Accordingly, the practice was added to the 2006 Texas MUTCD as an optional treatment.

Speed Limit Sign Conspicuity

Drivers approaching a city from a rural area may not notice a Speed Limit sign or be aware that they are on the outskirts of a small town. In this activity, researchers evaluated the impact of placing a red border around a Speed Limit sign to improve conspicuity of the sign and increase driver awareness of the lowered speed limit. Researchers evaluated the treatment at several study sites during the first three years of the project. The short-term findings from the first year of the project found a significant decrease in speeds when the red border was placed around the standard Speed Limit sign. The longer term effects were not as significant, but were beneficial, particularly with respect to the percentage of vehicles exceeding various speed thresholds above the speed limit (i.e., 5 mph over, 10 mph over, etc.). Based on the research results, the researchers recommend that a red border be included as an optional treatment to improve conspicuity of a Speed Limit sign where the speed limit is being reduced in advance of a city or town. This research was completed after publication of the 2006 Texas MUTCD, but the FHWA included the use of the red border as a Speed Limit conspicuity treatment in the proposed revisions to the 2003 national MUTCD.

Work Zone Sign Support Crash Test

The crashworthiness of temporary sign support structures is an important safety consideration in work zone safety. In this activity, researchers tested the effectiveness of a proposed work zone temporary sign support. The sign structure did not pass the crash test, but the test did identify necessary changes in the support design that allowed it to be successfully crash tested in a follow-up test conducted as part of a different project. The redesigned sign structure was then approved by the FHWA and is being used in Texas.

Extinguishable Message Left Turn Yield Sign

Protected-permissive left turn operation presents both challenges and opportunities for managing left turn movements at signalized intersections. More efficient traffic operations are among the benefits, while communicating the protected/permissive nature of the operation is among the challenges. In this activity, researchers evaluated the impact of an extinguishable left turn yield sign on safety and operations at a single signalized intersection in Atlanta, Texas. The sign displayed the legend “LEFT TURN YIELD” during the permissive portion of the phase and was dark during the red, yellow, and protected portions of the phase. Researchers conducted a before-and-after conflict analysis and evaluated the crash history. Both analyses indicated improvements. Based primarily on the safety benefit, the researchers recommend the sign be considered for use at appropriate intersections with a demonstrated history of high numbers of left turn crashes.

Lead-Free Yellow Thermoplastic Pavement Markings

The typical thermoplastic pavement marking material used on Texas highways contains encapsulated lead. In this activity, researchers evaluated the performance of experimental lead-free materials placed on two highways. At each location, researchers measured retroreflectivity and color performance of the material and compared their performance to performance requirements. At one of the sites, researchers were also able to compare the lead-free material performance to thermoplastic material containing lead that was placed at the same time at the same site. Researchers evaluated the materials over a one-year period and the results indicate that the lead-free material appears to perform in a manner that is consistent with the standard TxDOT leaded material with respect to retroreflectivity, nighttime 30 meter color, and 45°/0° illuminant A color readings. The lead-free material appears to differ in 45°/0° illuminant D65 daytime color readings from the leaded material; the difference is that the lead-free material color is closer to white than the leaded material.

Comparison of Marking Retroreflectivity Measurements Using Portable and Mobile Instruments

At the time of this activity, TxDOT relied almost exclusively upon portable (handheld) instruments to measure marking retroreflectivity, although contractors were beginning to use mobile retroreflectometers to measure marking retroreflective performance. In this limited activity, researchers compared retroreflectivity measurements made with both handheld and mobile instruments. Researchers made measurements with both types of instruments at six sites representing a range of marking and pavement conditions. The findings indicate that retroreflectivity measurements made with the two types of instruments are reasonably consistent with each other when the instruments are properly calibrated and are operated correctly. Since the conclusion of this activity, TTI has established a qualification program for mobile retroreflectometer certification to assist TxDOT in making sure that organizations that make mobile retroreflectivity measurements are qualified to do so and have demonstrated an ability to measure retroreflectivity accurately.

Retroreflective Signal Back Plates

Signal backplates were introduced to improve the visibility of traffic control signal heads, particularly when the signal head is viewed in front of a bright light source such as the sun. As the use of backplates became more prevalent, some agencies began to experiment with placing retroreflective sheeting along the edge of the backplate. In this activity, researchers evaluated a range of retroreflective strip color and width combinations at the Texas A&M Riverside Campus to identify the combination that appeared to be the most effective. They then conducted a before-and-after study of the backplates at an intersection using red-light and yellow-light running as the measures-of-effectiveness. The researchers were not able to identify any benefits from retroreflective backplates based on the limited field testing. However, before additional evaluations could be conducted, the FHWA issued an interim approval for the use of retroreflective backplates. As a result, the researchers did not conduct any further evaluations as part of this research project. The FHWA included retroreflective backplates in the proposed revisions to the 2003 national MUTCD.

Traffic Control Device Guidelines

A key benefit of this project is that it provided the ability to develop specific traffic control device guidelines for TxDOT to implement. During the last three years of this project, researchers developed four distinct sets of guidelines for TxDOT. These guidelines included three stand-alone documents and one chapter to be added to a TxDOT manual.

Sign Crew Field Book

The *Sign Crew Field Book* was originally developed for TxDOT as part of a previous TTI research project. Development of the original *Sign Crew Field Book* concluded in 2000, and the document had not been updated since. Recent developments in traffic control device practice, including the publication of the 2006 Texas MUTCD and updates to many of the Traffic Operations Division’s traffic engineering standard sheets, caused some of the content of the original *Sign Crew Field Book* to be out-of-date. In this activity, TTI researchers updated the content of the *Sign Crew Field Book* and updated the format so that it could be posted on the TxDOT web site as an on-line manual. In updating the field book, researchers first converted the content of the previous field book into the current TxDOT standard format for an on-line manual. They then reviewed the existing content and compared it to current standards and practices. Differences were noted and the material revised as appropriate. Researchers also met with

TxDOT staff to identify new material to be added to the field book. As material was developed and revised, the researchers met with TxDOT Traffic Operations staff on a regular basis to identify needed refinements. Draft chapters were posted on a protected web site to make them available to TxDOT staff for review. Researchers also conducted two webinars with TxDOT staff to review the updated material and identify additional changes. After TTI submitted the new Sign Crew Field Book to TxDOT at the conclusion of the project, the Traffic Operations Division sent it to the districts for an additional review. Afterward, TTI and TxDOT conducted an extensive review of all comments prior to approval for publication of the document.

Traffic Signal Warrant Guidelines

TTI researchers developed the original *Traffic Signal Warrants: Guidelines for Conducting a Traffic Signal Warrant Analysis* in 1998 as part of a previous research project. However, the traffic signal warrants were reformatted and updated with the publication of the 2000 national MUTCD, which carried over into the 2003 and 2006 Texas MUTCDs. The changes in the traffic signal warrants made it more difficult to use the 1998 guidelines. In this activity, researchers updated the traffic signal warrant guidelines document to reflect the warrants in the 2006 MUTCD. The updates included reorganizing the material to be consistent with the warrant structure in the 2006 Texas MUTCD and incorporating recent interpretations and other pertinent factors that have become available since the publication of the original guidelines. The updated guidelines provide step-by-step instructions for conducting a warrant analysis in a manner which optimizes the data collection and analysis. The guidelines also provide insights into the conduct of a warrant study, information which is not a part of the MUTCD. The result of this activity is a stand-alone publication that TxDOT can distribute as appropriate. Although intended for use by engineers (and technicians working under an engineer's supervision), one of the side benefits of the publication is its value in educating the public about traffic signal warrants and the application of those warrants.

Work Zone Implementation Handbook

In September 2004, the FHWA published a final rule on work zone safety and mobility that requires agencies to take certain steps regarding safety and mobility of work zones on "significant" projects. The impacts of this final rule could be substantial and TxDOT asked the research team to develop a document that would assist TxDOT personnel with the implementation of the final rule. The research team, working closely with Traffic Operations Division staff and a panel of TxDOT experts, developed the *Work Zone Implementation Handbook* to provide TxDOT staff with project level information that will help them to comply with the requirements of the final rule. The handbook includes an introductory chapter, a chapter summarizing the federal rule, a chapter that presents the TxDOT policy for implementing the rule, and two chapters that provide project level information and strategies for complying with the new TxDOT policy.

Pedestrian Accessibility Guidelines for Signalized Intersections

There has been an increasing emphasis on pedestrian accessibility at signalized intersections since the publication of the 2000 national MUTCD and this trend is expected to continue.

Beyond the MUTCD, there have been numerous other efforts to develop guidelines to improve pedestrian accessibility. In this activity, researchers synthesized available information from a variety of sources to create TxDOT guidelines for pedestrian accessibility at signalized intersections. The resulting document is formatted as a chapter that can be added to the appropriate TxDOT manual. The chapter covers curb ramps and blended transitions, accessible pedestrian signals, and countdown pedestrian signals.

Preliminary Assessments or Theoretical Evaluations of Traffic Control Devices

Another one of the benefits of this research project is that it provided the ability to do assessments of issues on a theoretical or limited basis. These types of assessments typically involved a low level of effort using readily available information and often represented a preliminary type of investigation that provided a sense of the need to conduct more detailed analysis. The researchers conducted five such activities on this project.

Dew Resistant Sheeting

During the second year of the project, a sign sheeting manufacturer approached researchers and TxDOT staff about a sheeting product under development that would reduce dew formation on the face of traffic signs. In this activity, researchers worked with the manufacturer to set up an automated process for monitoring dew formation on a test sign at the Texas A&M Riverside Campus. The evaluation results indicate that the test sheeting did have less dew form during early morning hours than the standard sheeting. However, despite the success of the initial evaluation, there has been no further development of this product and it is not commercially available.

Identification of No Passing Zone Locations

The MUTCD contains specific guidelines for the marking of no passing zones. These guidelines have traditionally been implemented by surveying methods or with two vehicles connected by a long cable or rope. Both are labor intensive and potentially intrusive on traffic flow. In this activity, researchers developed an automated process for identifying the starting and ending points of no passing zones based on the vertical roadway alignment. The process uses Global Positioning System data to establish the vertical profile of the road, then uses an algorithm developed through the research effort to identify locations that do not have the necessary sight distance. Limited field evaluations of the results indicate good agreement with existing no passing zones. However, the process does not address no passing zones based on horizontal alignment or intersections.

Pedestrian Countdown Signals

Pedestrian countdown signals were added to the Texas MUTCD in the 2006 edition but have not yet been widely retrofitted to all current intersections. In this activity, researchers developed guidelines for implementing countdown pedestrian signals at existing signalized intersections. The recommendations were based on a meta-analysis of previous research dealing with pedestrian behavior, costs, and impacts on safety. The resulting recommendations address where pedestrian countdown timers should be used and how they should be implemented. Early in 2008, the FHWA published proposed changes to the national MUTCD that would require pedestrian countdown timers to be installed for most new pedestrian signal heads and that they replace most existing pedestrian signal heads within ten years.

Sign and Marking Design for Super High-Speed Roadways

Speed limits have increased to 80 mph on some Texas Interstate Highways, and there is the potential that speed limits could be even higher on future highway corridors in the state. In this activity, researchers calculated the letter height and marking width that would be appropriate for freeway guide signs and pavement markings to provide a performance level consistent with that of current freeways. The researchers used available information and an analysis of visual angles to evaluate the need for larger sign legends and wider markings. The findings indicate that the minimum letter height would need to be at least 22 inches and the minimum marking width needs to be at least 6 inches. One of the challenges associated with implementing the larger letter height is that the width of the sign may be too great, leading to the need to split or duplicate the information in the signs.

Lateral Placement of Rumble Strips on Two-Lane Highways

Longitudinal rumble stripes have become a popular safety treatment in recent years. One of the TxDOT questions related to the use of rumble strips on the shoulder is where they should be laterally placed in the shoulder. In this activity, researchers conducted a theoretical examination of driver behavior leaving a lane to determine the optimal lateral placement of a shoulder rumble strip. Researchers utilized expected travel paths and driver reaction times to determine how far the rumble strip could be placed from the outside edge of a shoulder and still provide adequate time for a response. The results indicated that a more detailed analysis beyond the scope of this research effort was needed. Research Project 0-5577 was conducted to provide such a detailed analysis.

SUMMARY

Working with TxDOT staff, the TTI researchers were able to accomplish much during this five year project. Not only did the researchers conduct 17 separate activities, some of which have already been implemented, but they proved the value of a broad traffic control device project that has the ability to address a wide range of issues on a timely basis. Although the current project terminated in August 2008, TxDOT is continuing a similar activity with Project 0-6384, Evaluation and Development of Traffic Control Devices.

FOR MORE DETAILS

The research results and recommendations are documented in the following reports:

Report 0-4701-1, Evaluation *of Traffic Control Devices: First Year Activities*, by Elisabeth R. Rose, H. Gene Hawkins, Jr., Andrew J. Holick, and Roger P. Bligh

Report 0-4701-2, *Evaluation of Traffic Control Devices: Second Year Activities*, by H. Gene Hawkins, Jr., Roma Garg, Paul J. Carlson, and Andrew J. Holick

Report 0-4701-3, *Evaluation of Traffic Control Devices: Third Year Activities*, by H. Gene Hawkins, Jr., Matthew A. Sneed, and Cameron L. Williams

Report 0-4701-4, *Evaluation of Traffic Control Devices: Fourth Year Activities*, by H. Gene Hawkins, Jr., Cameron L. Williams, and Srinivasa Sunkari

Report 0-4701-5, *Evaluation of Traffic Control Devices: Fifth Year Activities,* by H. Gene Hawkins, Jr., Adam Pike, and Mehdi Azimi

To obtain copies of reports, contact Texas Transportation Institute at pubquest@ttimail.tamu.edu or see the TTI online catalog at http://tti.tamu.edu/publications/.