NEW ENGLAND TRANSPORTATION CONSORTIUM

2019 RESEARCH PROBLEM STATEMENT SOLICITATON

I. PROBLEM TITLE

Signing Alternatives for Improving Traffic Operations and Safety in Lane-Reduction Transition Areas

II. RESEARCH PROBLEM STATEMENT

The transition area upstream of a work zone or a lane drop is typically associated with significantly increased crash risk and reduced capacity1 due to frequent but often disorganized merge activities. The current merge signs in the MUTCD (W4-2, W9-1, & W9-2) and the lane-reduction arrow pavement markings in advance of the transition area tend to give drivers the incorrect impression that the continuing lane has priority over the ending lane. Under congested traffic conditions, such an impression and the small inter-vehicle space gaps make early lane changes in the W9-1 "Right/Left Lane Ends" word sign area a challenging task, particularly for heavy vehicles in the ending lane. This causes congestion in the lane-reduction transition area and excessive queuing upstream of it. Alternative signing could potentially be more effective than the current W4-2 "Lane Ends" symbol sign and W9-2 "Lane Ends Merge Right/Left" word sign in conveying the correct message that vehicles in both lanes have the same priority to continue travel, thus encouraging an orderly late lane merge/zipper merge that improves both traffic operations and safety.

III. RESEARCH OBJECTIVES

This research aims at developing and field testing signing alternatives in advance of lane-reduction transition areas. The field tests would require identifying approaches at signalized intersections with two exclusive through lanes and two receiving lanes that merge into one downstream lane within sight of the signal. The signal itself creates the congestion needed to carry out the study by releasing high-density (i.e., "congested") platoons of vehicles into the advance warning and transition areas. Before-and-after data would be collected to evaluate the performance of different signing alternatives. At each site, the background (i.e., before) data would be collected using the existing sign combination (e.g., W9-1 and W9-2), and the after data would be collected using proposed alternate signing combinations (e.g., MERGE AHEAD and BEGIN MERGE TAKE TURNS).

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[1] *Many studies have showed that capacity has reduced at lane-drop bottlenecks on highways, such as the following references: "Empirical Study of Traffic Features at a Freeway Lane Drop", and "Lane-changing in traffic streams".*

IV. COST ESTIMATE

$180,000

V. RESEARCH PERIOD

24 months

VI. URGENCY AND PAYOFF POTENTIAL

Lane-reduction transition areas are commonly seen on highways and at intersections due to roadway geometric design, work zones, and traffic incidents. Safe and efficient traffic operations in these areas are critical for reducing delay and improving system reliability. The existing signing combination may give some drivers an incorrect impression and contribute to increased delay and crash risk due to the varying interpretations of the message. Given the aging infrastructure in the New England area and numerous work zones, investigating driver behavior and developing safer and more effective traffic signs for lane-reduction transition areas has become imperative. Furthermore, a more efficient way of merging is needed since many right-of-ways are built out leaving no opportunity for widening to address bottlenecks associated with lane drops.

The proposed research will collect valuable data that advances our understanding of driver behavior in response to different signing combinations in advance of lane-reduction transition areas. If proven effective, the proposed signing alternatives could be adopted by the National Committee on Uniform Traffic Control Devices (NCUTCD) for inclusion in the MUTCD, and ultimately benefit drivers nationwide by contributing to more orderly merging behaviors, improving traffic operations and safety, and reducing driver frustration.

VII. PRELIMINARY LITERATURE SEARCH

To avoid duplicating research already published or in progress, the submitter of the Problem Statement will perform a brief literature search prior to submitting the Problem Statement. This literature search can be conducted using the Transportation Research Board's TRID database, available at https://trid.trb.org/. *The TRID database contains information on completed research as well as research in progress.*

A search using https://trid.trb.org with ”merge” as the keyword generated 47 records. An initial screening resulted in the following 12 projects. The most relevant ones are Projects #2, #7 and #12.

Projects #2 and #7 used driving simulator to model the effectiveness of various merge signs. The proposed research moves one step further and focuses on field testing. The collected data and findings are critical for understanding driver behavior and the true performance of various merge signs in lane-reduction transition areas.

Project #12 used video footage to show that the number of desirable merges increased by 10% with an alternative merge sign, which indicates that changes in static warning signs can influence driver merging behaviors. Although Project #12 conducted field tests, it only tested the W4-2 sign and one other experimental sign at two intersections for a total of only 384 hours (16 days, which would translate to approximately 4 days of video for each sign at each intersection). The collected video data was reviewed manually by researchers and the recorded merging events were classified empirically into four categories, with 1 being the most desirable merging pattern and 4 being the least desirable merging pattern. The valuable lane occupancy, signal phase, and car-following data was not analyzed in detail. Furthermore, automated data collection will yield a much more robust dataset that allows the team to easily discern and isolate congested periods for analysis, and allows for a greater number of study intersections to be included for a longer duration. The longer duration will allow the study team to determine when there are no longer any significant changes occurring in the driver behavior trends following the change of signs. The results of previous studies (particularly Projects #2, #7, and #12) are also useful for identifying signing alternatives to be tested in the field in this research.

1. Improving Work Zone Mobility through Planning, Design, & Operations. [Project]. Office of the Assistant Secretary for Research and Technology. Start date: 19 Jan. 2017. https://trid.trb.org/view/1501632

2. Driving Simulator Study of Merge Signs. [Project]. Office of the Assistant Secretary for Research and Technology, Midwest Transportation Center, Smart Work Zone Deployment Initiative, University of Missouri, Columbia. Start date: 1 Sep. 2015. https://trid.trb.org/view/1372824

3. Development and Demonstration of Merge-Assist System Using Connected Vehicle Technology. [Project]. Research and Innovative Technology Administration, Roadway Safety Institute. Start date: 1 Jun. 2014. https://trid.trb.org/view/1359190

4. TO-14020: Lane Change/Merge Fundamental Research: Phase 1. [Project]. Federal Highway Administration. Start date: 1 Jul. 2013. https://trid.trb.org/view/1370428

5. Freeway Merge Assistance. [Project]. Federal Highway Administration. Start date: 1 Jul. 2013. https://trid.trb.org/view/1254141

6. Modeling Traffic Flow at Merge Bottlenecks Considering Merging Location Choice. [Project]. Research and Innovative Technology Administration. Start date: 1 Jan. 2012. https://trid.trb.org/view/1239207

7. Studying the Bottleneck Issue at Work Zones and Assessing the Effectiveness of a Portable Dynamic Lane Merging System in Promoting Zip

Merging Behavior. [Project]. University of Rhode Island Transportation Center. Start date: 1 Jan. 2011. https://trid.trb.org/view/1231908

8. Advanced Freeway Merge Assistance: Harnessing the Potential of Connected Vehicles. [Project]. Federal Highway Administration. Start date: 28 Oct. 2009. https://trid.trb.org/view/1366733

9. Modeling Cooperative Driving Behavior in Freeway Merges. [Project]. Research and Innovative Technology Administration. Start date: 1 Sep. 2008. https://trid.trb.org/view/1249858

10. MERGING TRAFFIC PROCEDURE TO CONTROL TRAFFIC AT BOTTLENECKS. PART 2. [Project]. BUNDESMINISTER FUER VERKEHR. Start date: Jan. 1977. https://trid.trb.org/view/1049106

11. STUDY OF TRAFFIC FLOW AT THE END OF THE RAMPS OF GRADE-SEPARATED JUNCTIONS WHERE TWO LANES MERGE INTO ONE. [Project]. BUNDESMINISTER FUER VERKEHR. Start date: 1973. https://trid.trb.org/view/1061081

12. Alternative Merge Sign at Signalized Intersections, (pdf 737 kb), Final Report, Eric G. Feldblum, Connecticut DOT Report No. CT-2233-F-05-4, July 2005

VIII. RESEARCH KEY WORDS

Late merge, early merge, lane-reduction, safety, mobility

IX. ENDORSEMENT BY THE SPONSORING DOT (To be signed by the DOT representative to the NETC Advisory Committee through whom the Problem Statement is submitted.)

By signing the endorsement, the DOT representative is certifying that:

1. *The Problem Statement follows the required format.*
2. *The required literature search has been conducted.*
3. *The Problem Statement addresses a transportation issue of relevance to NETC and does not duplicate another Problem Statement being submitted at this time.*

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01-25-2019 — Date

Signature

X. ENDORSEMENT BY A SECOND EMPLOYEE OF THE SPONSORING DOT who agrees to chair the project's technical advisory committee (TAC) if the Problem Statement is selected for funding. (To be signed by a DOT staff person who has technical knowledge of the project topic and is committed to the research outcome.)

DOT Technical Endorsement: *I agree to chair the project's Technical Advisory Committee if this Problem Statement is selected for funding by NETC.*

Michael T. O'Donnell, P.E.	NHDOT
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Email	Tel.
Signature	1/25/19
	Date