Traffic Control Devices Pooled Fund Study

Comprehension and Legibility of Selected Symbol Signs Phase IV

Background

Traffic signs are an important communication tool that is used to convey regulatory, warning, and guidance information to road users. The process of understanding user requirements for new signs is particularly important for symbol signs, which rely on a common non-verbal interpretation by a large and diverse population of drivers.

The Traffic Control Devices Pooled Fund Study (TCD PFS) focuses on a systematic evaluation of novel traffic control devices (TCDs), employing a process that addresses human factors and operations issues for each TCD idea. As a part of this effort, the Federal Highway Administration (FHWA) Human Factors Team evaluated both existing and proposed new traffic signs. Sets of sign alternatives were evaluated for driver comprehension and legibility.

The TCD PFS panel selected the following sign messages for symbol development and evaluation: Lane Reduction Treatment; Temporary Traffic Control Bicycle/Pedestrian Access; Flashing Yellow Arrow; Alternative Fuels; Regulatory Signs for Midblock, Hybrid Beacon Pedestrian Crossings; Passenger Ferry; Bicycle Passing Law; Vehicle Prohibition Signs; Rail/Flangeway Gap Bicycle Warning; Blind Hill Warning; Toll Plaza Electronic Toll Interoperability; Recreation and Cultural Interest. Images of the sign alternatives are shown in the conclusions section.

Objectives

The FHWA Human Factors Team conducted Phase IV of the Symbol Signs study series to develop and evaluate proposed alternatives for new traffic signs. The goals of this study were as follows:

- Evaluate driver comprehension of selected signs.
- Measure the legibility distance of selected signs.
- Provide recommendations on signs that merit consideration for addition to the MUTCD.

Overview

Data were collected both at the Turner-Fairbank Highway Research Center and in a mobile laboratory. The mobile laboratory provided the opportunity for data to be collected outside of the Washington, DC, metropolitan area. Participants sat approximately 5 feet from a 60” LCD display. Signs were evaluated for comprehension and legibility.

Comprehension. The first portion of the study evaluated driver comprehension of each sign alternative in the different sign categories. This was a multiple stage process in which participants provided open-ended responses, multiple choice responses, and subjective rankings of the signs. The open-ended and multiple choice sections were between subjects factors, in which participants only saw one alternative for each sign category. Signs were shown in context, and questions were tailored for each sign type. Some, but not all, sign sets were ranked by perceived effectiveness. Participants were shown all sign alternatives and ranked each on how well the alternative would work to convey the intended meaning.

Legibility. Next, legibility distance (the maximum distance at which the participant can read text or decipher the elements on the sign) was assessed. Participants viewed the same signs for which comprehension questions were answered. Signs were presented one at a time on a black background. The sign presentation began at a simulated distance of 1000 feet (304.8 meters) and the sign expanded in size to simulate an approach speed of 45 mi/h. Participants pressed a button as soon as the sign became legible, and then described the sign aloud. If the participant was incorrect, the sign reappeared and continued to increase in size so the participant had another opportunity to indicate when the sign truly became legible. Correctness was deemed anything that confirmed the sign was legible to the participant.

RESULTS

CONCLUSIONS

This section shows the alternatives that were evaluated for each sign category and provides a brief overview of the findings and recommendations.

Lane Reduction

Table 1: Lane Reduction Sign Alternatives

Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
					

Alternatives 4 and 5 performed the best in terms of conveying the intended meaning (right lane ends) and not conveying unintended meaning (e.g. right lane closed, left lane closed, left lane ends). Although alternative 5 may be slightly easier for participants to understand than alternative 4, they both had high comprehension and both are currently in the MUTCD. Alternative 4 was recognized at a legibility distance significantly greater than all other alternatives, which is not surprising as symbol signs tend to have longer legibility distances than text signs. Either alternative 4 or alternative 5 would be acceptable for use. Alternative 6 also performed well in terms of comprehension and is currently in the MUTCD, but it had significantly shorter legibility distances than all other signs.

Temporary Traffic Control Bicycle/Pedestrian Access

In general, participants tended to think the detour applies to the transportation mode(s) shown on the sign, however there is still a chance that motorists may think the sign applies to them. This type of sign may not be completely clear as evaluated. It is ideal if the sign is placed and angled in such a way that it is clear that the sign is directed only toward pedestrians and bicyclists.

Table 2: Temporary Traffic Control Bicycle/ Pedestrian Access Sign Alternatives

Alt. 1	Alt. 2	Alt. 3
		

Flashing Yellow Arrow

The sign was placed in context next to a signal mast. The yellow arrow was presented as flashing, on a solid state, and blank. There were no significant differences between sign alternatives, nor was there a significant interaction between the flashing state of the signal mast and sign alternative. Participants generally preferred alternatives 3 and 2 over alternative 1. With only 70% of participants reporting that they need to yield to oncoming traffic when viewing the flashing yellow arrow with no sign, it may be premature to not use a sign.

Table 3: Flashing Yellow Arrow Sign Alternatives

Alt. 1	Alt. 2	Alt. 3	Alt. 4
			(no sign)

Blind Hill Warning

Although it is important for drivers to understand that the sign is conveying the presence of a hill, it is more important that they understand that there may be a sight obstruction. Alternative 1 had the highest comprehension, legibility distance, and subjective ranking of effectiveness. Therefore, it is recommended that alternative 1 (which is currently in the MUTCD) continue to be used.

Table 4: Blind Hill Warning Sign Alternatives

Alt. 1	Alt. 2	Alt. 3	Alt. 4
			

Recreational and Cultural Interest

Eighty-four different signs were evaluated individually; the signs and results can be found in the full research report.

RESULTS

CONCLUSIONS (CONT.)

Alternative Fuels

Participants were more likely to be fully correct (i.e. understand what type of fuel is available) when viewing signs with the supplemental placards than when viewing signs without the supplemental placards. Participants had particular difficulty understanding alternatives 11 and 12. It is recommended that Alternative fuel signs should include the gas pump symbol and a supplemental placard indicating what type of alternative fuel is offered.

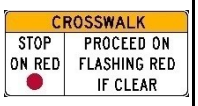
Table 5: Alternative Fuels Sign Alternatives

Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
					
Alt. 7	**Alt. 8**	**Alt. 9**	**Alt. 10**	**Alt. 11**	**Alt. 12**
					

Midblock Hybrid Beacon Pedestrian Crossing

There was no statistical difference between signing alternatives in terms of decision to yield and stop, therefore any of the alternatives would be adequate; however, alternatives 1 and 2 had higher legibility distances.

Table 6: Midblock Hybrid Pedestrian Crossing Sign Alternatives

Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
				(no sign)

Passenger Ferry

In general, participants understand any of the sign alternatives to indicate that there is a ferry. However, people generally tend to think that only the modes of transportation shown in the sign are the ones who can use the ferry. If the intent of the sign it to convey that multiple user types can use the ferry, then the sign should include each user type so people understand who can use the ferry.

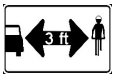
Table 7: Passenger Ferry Sign Alternatives

Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5
				

Bicycle Passing Law

Based on the results of the open-ended and multiple choice questions, alternatives 2 and 3 resulted in the best comprehension. When considering comprehension, legibility, and ranking, alternative 3 is the most effective.

Table 8: Bicycle Passing Law Sign Alternatives

Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
					

Rail/Flangeway Gap Bicycle Warning

Sign alternative had a significant influence on participant response. Of the signs tested, alternative 2 is the best option for signing for a rail/flangeway gap bicycle warning. Alternative 2 had the highest comprehension and was selected as the top choice by the majority of participants.

Table 9: Rail/Flangeway Gap Bicycle Warning Sign Alternatives

Alt. 1	Alt. 2	Alt. 3	Alt. 4
			

RESULTS

CONCLUSIONS (CONT.)

Vehicle Prohibition

Table 10: Vehicle Prohibition Sign Alternatives

Alt. 1	Alt. 2	Alt. 3
		

Between 47.1% and 61.7% of participants indicated in their open-ended responses that the pictured mode of transportation was prohibited; this level of comprehension indicates that the symbols may not accurately indicate what the purpose might be. Although participants tended to understand more that the pictured mode was prohibited in the multiple choice question, they were less likely to say that other modes were also prohibited. Therefore, text signs may be better for these types of signs. Or, if a symbol is used, there should also be text to go with them.

Toll Plaza Electronic Toll Interoperability

Table 11: Toll Plaza Electronic Toll Interoperability Sign Alternatives

Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
					

Regardless of which symbol is selected, education will be key in ensuring that road users understand the concept of interoperability. Based on the results, there is no reason to recommend one symbol over another since none were statistically significant, but should some symbols be considered, alternatives 1, 3 and 6 had slightly higher comprehension than the other alternatives for the open-ended question and for the lane-choice question when no education was given (one third of participants were educated on interoperability prior to answering questions).

This study was conducted by the FHWA Human Factors Team. For more information about the study, or for a copy of the full research report:

- Visit http://http://www.pooledfund.org/Details/Study/565
- Contact Michelle Arnold at (202) 493-3395 or by email michelle.arnold@dot.gov

The objective of the Traffic Control Devices Pooled Fund Study (TCD PFS) is to assemble a group composed of State and local agencies, appropriate organizations and the FHWA to 1) establish a systematic procedure to select, test, and evaluate approaches to novel TCD concepts as well as incorporation of results in the MUTCD; 2) select novel TCD approaches to test and evaluate; 3) determine methods of evaluation for novel TCD approaches; 4) initiate and monitor projects intended to address evaluation of the novel TCDs; 5) disseminate results; and 6) assist MUTCD incorporation and implementation of results.

To join the TCD PFS, or for more information about the TCD PFS:
•Contact Michelle Arnold at (202) 493-3390 or email michelle.arnold@dot.gov or contact Kevin Sylvester at (202) 366-2161 or email kevin.sylvester@dot.gov.
•Visit www.pooledfund.org and search for study# TPF-5(316).

Traffic Control Devices Pooled Fund Study Members

ATTSA, Roger Wentz
Alabama DOT, Kerry NeSmith
Broward Co., FL, Lee Billingsley*
Caltrans, Chris Engelmann
City of Los Angeles, John Fisher
Colorado DOT, K.C. Matthews
Delaware DOT, Scott Neidert, Jr.
Florida DOT, Alan El-Urfali
Georgia DOT, Landon Perry
IBTTA, Maurice Palumbo
Illinois DOT, Kyle Armstrong
Iowa DOT, Tim Crouch
Kansas DOT, Brian Gower
Maryland DOT, Jialin Tian
Massachusetts DOT, James Danila
Minnesota DOT, Janelle Anderson
Mississippi DOT, James Sullivan
Missouri DOT, Tom Honich
Montana DOT, Danielle Bolan
Nebraska DOR, Matt Neeman
Nevada DOT, Jeannie Drown
New Hampshire DOT, Michael O'Donnell
New Jersey DOT, David Martin
New York DOT, Barbara Abrahamer
North Carolina DOT, Ron King
Oregon DOT, Michael Kimlinger
Pennsylvania DOT, Justin Smith
South Carolina DOT, Joey Rhoades
Texas DOT, Doug Skowronek
Wisconsin DOT, Travis Feltes
FHWA, Michelle Arnold
FHWA, Kevin Sylvester
FHWA, Rosemarie Anderson
FHWA, John Seabrook
Leidos for FHWA, Stacy Balk
Toxcel for FHWA, Bryan Katz

* Retired

FHWA Publication No: FHWA-HOP-09-024