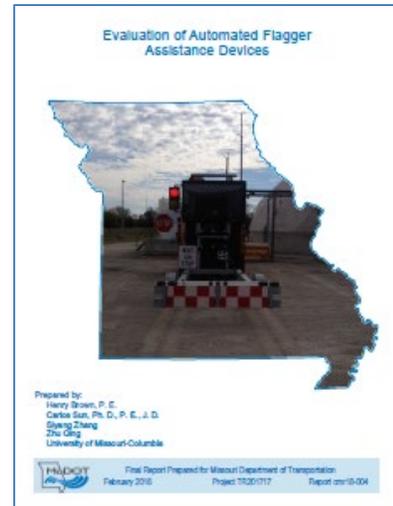# *Research Summary*

Evaluation of Automated Flagger Assistance Devices

Automated flagger assistance devices (AFADs) are designed to improve worker safety by replacing flaggers who are typically located near traffic approaching a work zone. The objective of this project was to evaluate the effectiveness of a new AFAD developed by the Missouri Department of Transportation (MoDOT). The MoDOT AFAD configuration (see figure), involving STOP/SLOW paddles, Red/Yellow lights, and a changeable message sign (CMS), was incorporated onto a truck-mounted attenuator for operator protection.

AFAD Mounted on TMA

The scope of this project included three phases: a field test with CMS, a simulator study (both with and without CMS), and a tentative field test without CMS. The third phase was deemed unnecessary as the use of CMS was found to be desirable in the first two phases. The first two phases were each followed by a survey that captured driver preferences and understanding. Detailed quantitative driver behavior measures were used for the first time in this study to compare the effectiveness of human flaggers versus AFADs in the United States.

For the field study, video data was collected for two days in a work zone on MO 23 in Knob Noster, Missouri. One direction had a human flagger while the other direction had the MoDOT AFAD. The flagging methods were reversed for the second day. Driver behaviors at both ends of the AFAD and human flagger were recorded by cameras. There were 334 total queues collected, of which 186 were for the AFAD, and 148 were for the flagger. The performance measures of vehicle approach speed, stop location, intervention rate, and first vehicle approach speed **all favor the AFAD over the flagger**.

The reaction time for AFAD was significantly longer than for the flagger (4.41s vs. 1.69s) and may cause extra traffic delay. But the reason for the longer delay is not completely clear.

For the field survey, the research team distributed 104 hard copies and 182 online links to drivers after they drove through the work zone with the AFAD. A total of 42 responses were received. **The MoDOT AFAD was preferred over the flagger by almost 80 percent of the participants**. Over half of the respondents (54

percent) preferred the AFAD much more than the flagger, and no respondents preferred the flagger much more than AFAD.

After Phase One was completed, the Phase Two simulator study was conducted. In the simulator study, four setups were evaluated: human flagger, MoDOT AFAD, AFAD with alternative sign, and AFAD without CMS. There were 32 participants in the study.

The driving simulator results showed that the MoDOT AFAD significantly reduced average approach speeds (8.4 mph), increased full stop distance (44 feet), and increased the first brake location where participants reacted to the stop controls (58 feet) as compared to the human flagger. There were no interventions for the MoDOT AFAD, while the human flagger had an intervention rate of 14 percent. **The simulator results indicated that the MoDOT AFAD performed better than the human flagger**.

> *"Both the field and simulator study clearly indicated that the MoDOT AFAD was a valid and effective replacement of the human flagger."*

The post-simulator survey results showed that most drivers understood the flagging devices (93 percent flagger, 90 percent AFAD with alternative sign, 83 percent MoDOT AFAD, and 83 percent AFAD without CMS).

Overall, the order of average participant rankings, from the most preferred to the least preferred, was: MoDOT AFAD, AFAD with alternative sign, human flagger, and AFAD without CMS. Participants also rated clarity, visibility, safety, and efficiency of each flagging methods. **The MoDOT AFAD scored the highest in all four categories**, and the AFAD with alternative sign had the second highest scores in all four categories. AFAD without CMS scored the lowest in clarity. The human

flagger had the lowest score in visibility, safety, and efficiency.

The simulator, field test, and survey results were consistent in showing that MoDOT AFAD performed better than flaggers using multiple MOEs. These results are highly encouraging for any jurisdictions who are interested in pursuing the use of AFADs to improve work zone and worker safety.

Project Information

PROJECT NAME: Auto Flagger	
PROJECT START/END DATE: December 15, 2016-June 30, 2018)	
PROJECT COST: $176,275	
LEAD CONTRACTOR: University of Missouri-Columbia	
PRINCIPAL INVESTIGATOR: Henry Brown	
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