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DEPARTMENT OF TRANSPORTATION

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TECHNICAL SUMMARY

Technical Liaison:
Michael Kronzer, MnDOT
Michael.Kronzer@state.mn.us

Project Coordinator:
Deb Fick, MnDOT
Deb.Fick@state.mn.us

Principal Investigator:
Shauna Hallmark, Iowa State University

PROJECT COST:
$278,516

Researchers collected data with arrays of video cameras, which were set up to record driver behavior at approximately face level.

Evaluating Driver Responses to Intersection Collision Warning Systems

Researchers evaluated the effectiveness of rural intersection collision warning systems, which have the potential to reduce crashes and save lives. Results from this project will help MnDOT decide when and where to deploy additional systems.

What Was the Need?

To help reduce crashes at high risk rural intersections where traffic volumes do not warrant a traffic signal, MnDOT has been installing intersection collision warning systems (ICWS). When vehicles on a major roadway are about 6.5 seconds from an intersection with an ICWS, the system alerts drivers on the minor roadway with flashing yellow beacons and a Traffic Approaching warning displayed on an electronic dynamic message sign. When vehicles on the minor roadway approach the stop signs at these intersections, drivers on the major roadway see a single flashing beacon and an Entering Traffic message.

As of 2017, MnDOT has installed these systems at more than 50 locations throughout Minnesota. Early studies indicate that their presence lowers intersection speeds, reduces conflicts such as near-crashes or lane changes to avoid collisions, and reduces total crashes by 46 percent and severe crashes by 72 percent. However, MnDOT was interested in determining whether the systems would lead to a "spillover" effect, in which drivers are habituated to expect and depend on the presence of an ICWS, leading them to be less likely to fully comply with stop signs when the systems are not present or not activated. It was also interested in determining the traffic volumes at which an ICWS would be continuously activated, since the system would then appear to be static to drivers and likely less effective.

What Was Our Goal?

The goals of this project were to:

- Evaluate driver behavior before and after ICWS installation to determine whether the systems reduced conflicts and improved stopping behavior, gap selection and intersection scanning.
- Evaluate driver behavior at nearby control intersections without these treatments to determine whether the general presence of an ICWS negatively affects driver behavior by conditioning drivers to be less cautious when the systems are absent.
- Determine the traffic volumes at which the systems would be continuously activated.

What Did We Do?

Researchers collected video data of driver behavior using arrays of video cameras at five intersections, both before and after ICWS installation. They also collected video data at five control intersections without these systems, chosen because they were close to treatment intersections and were expected to have similar drivers.

At these intersections, researchers measured the following driver behaviors:

- **Stopping:** Whether drivers on the minor roadway came to full stops at intersections, rolled through them with some braking at less than 10 mph or did not stop at all (at greater than 10 mph).
- **Gap size:** The size of the gap between oncoming vehicles on the main roadway that was chosen by drivers turning from the minor road, measured as the difference in arrival times between these vehicles.

continued

"We wanted to make sure that drivers didn't simply use these systems as traffic signals and roll through stop signs when the systems weren't activated."

—Shauna Hallmark,
Associate Director, Iowa State University Center for Transportation Research and Education

"Intersection collision warning systems put a good, midrange cost option in MnDOT's safety toolbox. This study helped validate the system's effectiveness."

—Michael Kronzer,
ITS Project Manager, MnDOT Traffic Engineering

ICWS installations are not currently widespread in the United States. Minnesota is at the forefront of deploying them and evaluating their effectiveness.

- **Glances:** The number of times drivers looked left and right, as a measure of the thoroughness of their intersection scanning before making a turn.
- **Conflicts:** Whether drivers on the main roadway used brakes, slowed significantly or changed lanes, as well as experienced near-crashes, in response to vehicles turning from the minor roadway. A near-crash was an event where vehicles nearly collided or made significant evasive maneuvers to avoid a collision.

Researchers also used microsimulation computer modeling to determine the threshold combinations of major and minor roadway approach volumes for which an ICWS is likely to be continuously activated.

What Did We Learn?

Researchers found that ICWS installations significantly improved drivers' stopping behavior: Drivers were 50 percent more likely to come to a complete stop when the system was active. At control sites, no change in stopping behavior was found, indicating that drivers were not habituated to become less cautious when an ICWS was absent. Drivers' gap selection and intersection scanning also increased after the installation of these systems, and near-crashes and other conflicts were reduced. Computer modeling showed that an ICWS would be continuously activated at 1,600 vehicles per hour. Researchers do not recommend installations at traffic volumes approaching this threshold.

What's Next?

In 2018, MnDOT will finish collecting three years of before-and-after crash data at intersections with ICWS installations. The agency will analyze this data and the results of the current study to determine whether to continue to install these systems at candidate locations throughout the state. MnDOT is also conducting a human factors study on the optimal messaging for ICWS signs and is interested in methods to remotely alert the agency when systems need maintenance. Researchers are continuing to analyze the data from this project about driver behavior on the major roadway.

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Research Services & Library
MS 330, First Floor
395 John Ireland Blvd.
St. Paul, MN 55155-1899
651-366-3780
www.mndot.gov/research

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