Study of Effectiveness of Collision Avoidance Technology

How drivers react and feel when using aftermarket collision avoidance technologies

Executive Summary

Newer vehicles, including commercial vehicles, are being increasingly integrated with collision avoidance technologies to avoid accidents and the losses that result. This raises the question, what about the commercial fleets that are currently in service without this technology?

Missouri Employers Mutual, Missouri's number one provider of workers compensation insurance, understands firsthand the need to reduce accidents. For that reason, MEM commissioned a study with the University of Missouri's College of Engineering to understand the impacts of aftermarket collision avoidance technologies in vehicles.

There were two phases of the research:

1) Controlled test to study how drivers react to the technology; and
2) Real-world commercial testing with Older Adults Transportation, a passenger van service.

The overall results of the two phases predict crash reductions with the introduction of collision avoidance technology. In phase one, drivers' perceptions were measured. A major finding indicated the technology did not significantly add to the burden of drivers.

During the phase two study, three out of four drivers showed positive differences in driving behavior during the testing period. Specifically, the number of warnings recorded by the Mobileye system in active mode versus stealth mode was reduced once the drivers heard the warnings in active mode.

The driver survey results showed mixed results on the trust the professional drivers had with the systems. Sixty percent indicated confidence in the lane departure warning system. Forty percent showed confidence in the forward collision feature of the device. The researchers also saw reaction time differences between the lane departures and forward collision warnings in phase one of the project.

The overall results of the two phases predict crash reductions with the introduction of collision avoidance technology.

It became apparent through the study that Safe Drive and Mobileye systems had less false alarms and, therefore, more driver trust in the systems. False positive warnings will create a distrust, like the boy who cried wolf as the old fable goes.

Data also suggested that visual and audio warning systems provided better driver responses. Less sophisticated systems, such as the Garmin, although simple to operate, generated more false positives that tended to annoy drivers, perhaps leading them to turn off the safety features.

The findings here are not intended to be a recommendation on any particular collision avoidance technology. They are, however, intended to give the reader the relevant facts about how the study subjects interacted, used and perceived the technology on real road driving test protocols. The full technical report is available at worksafecenter.com.

Study Design

The University of Missouri's College of Engineering was engaged to perform the selection and analysis of several aftermarket collision avoidance technologies. Dr. Jung Hyup Kim, Assistant Professor, in the industrial engineering department was selected to lead the study in his lab at the university.

Dr. Kim's research focus is on how humans interact with machines, in general, but more specifically measuring their perceptions about these interactions. As Kim evaluated the previously conducted research, he found research around the sensitivity of the technologies. However, no previous studies had measured the drivers' visual perceptions of using the technology in their daily work.

The study was designed to understand how drivers react and feel when using aftermarket collision avoidance technologies.

Technologies Selected: Cost, Installation and Function

Four devices were selected for the initial testing. All four devices provided warning for lane departure ("LDW") as well as front end collision ("CDW"). The devices were chosen based upon their installation complexity and cost. The study would be able to understand the differences in driver reaction between different systems at different complexity and price points.

Phase 1 Testing Methodology

The first phase of the testing was done utilizing non-professional drivers in a rented Chevrolet Malibu. The goal of the test was not the sensitivity of the equipment but how the drivers interacted with the technology on a real road course. So, in short, it is how the drivers were impacted by the inclusion of the technology in their driving environment. This is critical as no one makes technology and sells it if it does not work, at least on some level.

The study used 20 students, navigating a 9.3 mile course in and around Columbia, MO. The route was designed to reflect a typical driving pattern of a Mizzou student. The students were divided into four groups of five, each driving the route multiple times using one of the technologies. Each technology was evaluated by five different students. The study was evaluating the perception of the driver to the technology. Thus, several measurements were being taken at the same time to understand the impact of the technology on the driver.

> ***Three out of four drivers showed positive differences in driving behavior during the testing period.***

The study measured the following attributes, using industry-acceptable methods:

- An eye tracker—it shows where the eyes are focused at any given time.
- An outside 360 degree camera—this allows the researchers to see what was happening in the environment at any given time.
- An arm activity tracker—it gauges how the arms are moving, at any given time, via the sensors.
- Inside camera—this gives the researcher exposure to the conditions inside the vehicle.

The key part of this study was to combine the data in a time series and match it to warning events from the technology to measure the driver's perceptions of the technology. The baseline data (measuring the drivers without added stress of the warnings) was compared to when the study participants were using the technology.

The data suggested that warning events from the Audiovox, Garmin and RD-140 increased the stress of the drivers during the study. The Mobileye did not appear to increase the stress of the drivers.

Detail of Technology, Cost and Installation Complexity				
Device	**Cost**	**Installation**	**Driving behavior improvement (%)**	**Driver workload/ fatigue increase (%)**
Garmin NuviCam LMTHD	Around $300	No technician required, simple dash mount.	19.76	4.66
Audiovox LDWS 100	Under $500	No technician, installation was 30 to 60 minutes	9.16	4.88
Mobileye 560	The university paid around $1,400.	This device requires a technician, which is included in the purchase price	31.78	0.55
Safe Drive Systems RD-140	The university paid around $1,900.	This device requires a technician, which is included in the purchase price listed	30.84	6.63

Phase 2 Testing Methodology

Phase one was critical to obtain baseline data on how drivers actually perceive the use of technology. Phase two of the study focused on bringing the technology into a commercial setting, using professional drivers. Mizzou partnered with Older Adults Transportation Service (OATS) where five professional drivers volunteered for the study. All of the drivers had enough experience to be considered expert commercial drivers.

Based upon the phase one data, the Mobileye 560 system was selected for phase two. The Mobileye systems were installed and operated in stealth mode for a period of three weeks to establish baseline data of driving behavior as measured by the technology. Stealth mode would send warning data to Mobileye without warning the driver. The systems were then used with the warnings on during their normal driving duties for three weeks. The OATS drivers used the technology in active mode, meaning the lane departure and collision detection warnings were on in both audio and visual mode.

The study did not use the same data collection method as the phase one study. The data was collected from the drivers using a survey of their perceptions over the testing period. This qualitative data in combination with the quantitative data of phase one was enough to draw conclusions on how the drivers' performance of their driving duties were impacted by the technology.

Performance and Insights

The main takeaway from phase one was that well-designed collision avoidance technologies installed aftermarket did not create a distraction, thus, did not increase the workload of the driver. The systems generally worked as designed; however, some interesting facts about the warning systems emerged.

First, the more robust systems that led to fewer false warnings were more effective as the drivers paid more attention to the alarms. There were some slow reaction times for the frontal collision warning as opposed to the lane departure warning. This led the researchers to recommend a different warning system such as a tactile vibration system somewhere in contact with the driver. A tactile vibration system was not offered on any of the test devices. Future studies could involve working with the CAT technology providers to offer a tactile warning feature based upon this study's results.

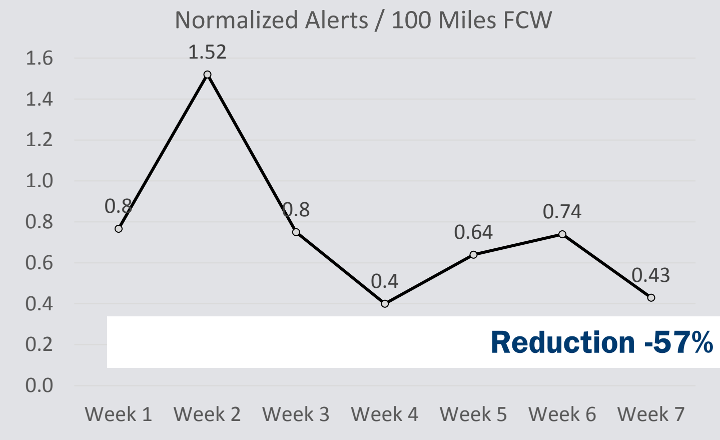
Overall, the Mobileye and Safe Drive systems performed the best. It should be noted the Safe Drive system uses radar technology and therefore works better in driving in obscured conditions. The Mobileye utilizes cameras with integrated technology to improve the vision of the system. However, the warning system of Mobileye appeared to perform the best and was therefore preferred.

In phase two, the main takeaway was there was a good acceptance of the professional drivers to the system installed, the Mobileye 560. There were some concerns noted by the drivers. The warning systems, which were audible to the passengers may upset them.

During the phase two study, 75 percent of drivers showed significant differences in driving behavior during the testing period. Specifically, the number of warnings recorded by the Mobileye system in active mode versus stealth mode was reduced once the drivers heard the warnings in active mode. Meaning, the drivers were more careful once the technology was turned on.

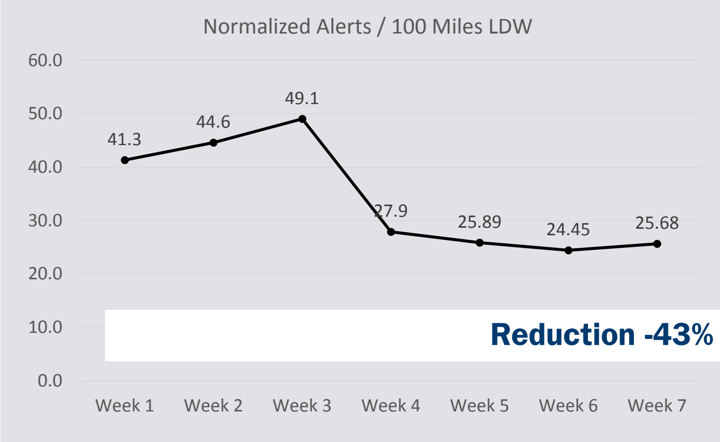
Forward Collision Warning

Average Stealth 1.01 Week 7 0.43



Improved Driving Patterns Lane Departure Warning

Average Stealth 45.0 Week 7 25.68



Results showed:

- 43 percent reduction in lane departure warnings from the average during the first three weeks to the seventh and last week of the test.
- 71 percent reduction in headway monitoring warnings (following a vehicle too close) during the same period.
- 57 percent reduction in forward collision warnings during the same period.

The driver survey results showed mixed results on the trust the professional drivers had with the systems. Sixty percent indicated confidence in the lane departure warning system. Forty percent showed confidence in the forward collision feature of the device. The researchers also saw reaction time differences between the lane departure and forward collision warnings in phase one of the project.

system should be designed to minimize the probability of false warnings and to increase the effective warning rate. Since driver distraction contributes to a large percentage of motor-vehicle crashes, the warnings should be designed to avoid any visual distractions.

A copy of the full technical report is available on http://www.worksafecenter.com/safety-resources/PDF/Collision_Avoidance_Technology_Report.pdf.

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