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What today's advanced driver assistance systems can tell us about the self-driving future

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Summary

The United States has made enormous progress in reducing the toll from motor vehicle crashes, thanks to safer vehicles, better laws and enforcement, and traffic engineering improvements. Of those factors, vehicle improvements have played the biggest role in recent years. In contrast, efforts to reduce crashes by changing driver behavior have largely stalled.

Automation is the next frontier in vehicle improvements and could one day address the problem of human behavior by taking it out of the equation completely. That day remains far in the future, however.

Experiences with existing crash avoidance technologies can give us some clues regarding the potential benefits and pitfalls of emerging automation technologies. IIHS research has documented safety benefits from some features, including electronic stability control and automatic braking. On the other hand, studies of insurance claims have not found consistent benefits from lane departure warning systems. These results show how crucial it will be to monitor new technologies to see if they deliver on their promise. Policies to help ensure the availability of information about which specific vehicles are equipped with which features would help researchers track the effectiveness of driver assistance systems.

Driver attitudes toward technologies will be key to ensuring new features reach their potential. Our research has shown that driver acceptance of technology varies.

We expect driving automation to enter the market gradually. During these years of technical evolution, some drivers may fail to understand the limitations of the systems and become overly reliant on them. New features should be designed in such a way as to make their limitations clear.

While automation has the potential to greatly reduce the toll from crashes, it would be a mistake to focus on it to the exclusion of proven countermeasures. Things like lower speed limits and strict enforcement of seat belt laws can provide benefits now, while we await the self-driving future.

Introduction

The Insurance Institute for Highway Safety (IIHS) and its sister organization, the Highway Loss Data Institute (HLDI), are nonprofit research institutes that identify ways to reduce deaths, injuries, and property damage on our highways. We are wholly supported by voluntary contributions from companies that sell automobile insurance in the U.S. and Canada. Thank you for the opportunity to testify on emerging automated driving technologies.

The United States has made enormous progress in reducing motor vehicle crash deaths over the past half a century. A combination of safer vehicles, better laws and enforcement of those laws, and traffic engineering improvements have cut the rate of crash deaths per population to nearly half of what it was in 1975.[1] The rate of crash fatalities per 100 million vehicle miles traveled is one-third the rate in 1980.

Out of all these types of countermeasures, it is vehicle improvements — including more crashworthy structures, front and side airbags and electronic stability control (ESC) — that have driven most of the decline in driver death rates since the mid-1990s.[2] In contrast, efforts to reduce crashes by changing driver behavior have largely stalled. Speeding, alcohol-impaired driving and lack of safety belt use all remain persistent problems.

Automation is the next frontier in vehicle improvements and could also address the problem of driver behavior. Full automation has the potential to make the human propensity to make poor decisions and errors irrelevant. In a study of police-reported crashes occurring during 2005-07 where at least one vehicle was towed from the scene, researchers found that a driver’s error or physical state had led to 94 percent of the crashes.[3] If automation can eliminate all crashes involving driver-related factors, then thousands of lives will be saved each year.

At the moment and for the foreseeable future, however, human drivers are still a key part of the equation. The safety potential of partial automation will be limited in large part by the way human drivers interact with driver assistance systems on their own vehicles and with fully automated vehicles with which they may share the road.

What we can learn from existing crash avoidance features

Although full driving automation for most vehicles remains far in the future, crash avoidance features that automatically assume control over vehicle motion when drivers fail to adequately respond to crash hazards aren't new. These include ESC and automatic braking systems. Our research has already documented injury-preventing benefits of these features.

ESC, which has been required on all new passenger vehicles since the 2012 model year, helps prevents sideways skidding and loss of control. The technology reduces the risk of a fatal single-vehicle crash by 49 percent and cuts the risk of a fatal multiple-vehicle crash by 20 percent for cars and SUVs.[4] Its effectiveness in preventing rollover crashes is even more dramatic. Years ago, SUVs were considered dangerous vehicles because their high centers of gravity made them prone to rolling over. That is no longer the case, thanks to ESC, which reducing the risk of fatal single-vehicle rollover crashes by 75 percent for SUVs and by 72 percent for cars.[4]

More recently, automatic control of vehicle brakes has proven to be an effective countermeasure against front-to-rear crashes. Front crash prevention is our name for systems that can detect an impending collision with the vehicle in front and warns the driver to brake, automatically brakes on its own or performs a combination of these functions. In a study of police-reported front-to-rear crashes, we found that systems with automatic braking reduce rear-end crashes by about 50 percent.[5] Studies by HLDI of insurance claim rates have also shown benefits for front crash prevention systems with and without automatic braking.[6,7,8,9,10,11,]

Despite these success stories, not all crash avoidance features have been shown to be effective. For example, HLDI examined the effectiveness of lane departure warning systems from six manufacturers and did not find any consistent changes in rates of insurance claims covering damage to at-fault vehicles, which is the type of claim that would likely follow a single-vehicle run-off-road crash.[7,9,12,13]

The disparate results for the effects of crash avoidance technologies point to one of our concerns about driving automation — namely, that there is no guarantee that the technology will deliver on its promise. Consequently, it will be important to continually monitor the effects on safety of new technologies entering the market. The studies mentioned above were only possible with the close cooperation of a few automakers who helped us identify by Vehicle Identification Number (VIN) the specific vehicles that were equipped with a range of optional features. Unfortunately, there is no comprehensive database linking VINs to information about what features are present on a given vehicle. Government policies aimed at ensuring the availability of such data for highway safety research would greatly enhance our ability to study the effectiveness of emerging technologies.

Driver attitudes

Collision avoidance and driving automation systems can't reach their crash-reduction potential if drivers don't use or respond appropriately to them. A recent IIHS observational study illustrates how driver attitudes toward advanced driver assistance systems can vary depending on how the feature is implemented.[14] We observed vehicles from eight manufacturers brought to dealership service centers to see if their front crash prevention and lane-maintenance systems (i.e., lane-departure warning, lane-departure prevention or active lane-keeping) were turned on. While front crash prevention was activated in 93 percent of vehicles we observed, lane-maintenance systems were turned on in only 51 percent of vehicles.

We also studied driver trust in advanced technologies in a more direct way by inviting our own employees to drive vehicles equipped with adaptive cruise control, forward collision warning, lane-departure warning, active lane-keeping and side-view assist systems. Fifty-four employees took part in this study, using the vehicles for days or weeks at a time for both commuting and longer trips. Overall, drivers did not express strong trust in any of the technologies.[15] Trust was highest for side-view assist and lowest for active lane-keeping. Trust in adaptive cruise control and side-view assist varied among vehicles.

Pitfalls of partial automation

No matter how quickly technology develops, it will take at least 25 years before nearly all vehicles on U.S. roads have today's latest technology. This estimate is based on a HLDI study that examined how long it takes for new features to be present in 95 percent of registered vehicles.[16] Thus, if the government were to require that all new vehicles sold in the U.S. be fully automated starting tomorrow, it would still be 2042 before nearly all vehicles on the roads were fully automated.

More realistically, we think driving automation will enter the market in a piecemeal fashion. Over time more and more of the driving task will be able to be automated. During these years of technical evolution, we are concerned that some human drivers will fail to understand the limitations of the systems on their vehicles and crash because they are overly reliant on them. Driving automation systems should be designed in ways that make their limitations clear to human operators.

It is also worth noting that partial automation may be of limited benefit in many kinds of crashes. We recently examined records of crashes caused by drivers drifting from their lanes. We found that 34 percent of drivers in lane-drift crashes were asleep or otherwise incapacitated because of a medical issue or alcohol or drug use.[17] For those drivers, lane-maintenance systems would have little relevance. Even if these vehicles had been brought back into their lanes, they likely would have crashed ultimately. To be effective in such cases, a crash avoidance system would have to bring the vehicle to a stop on the side of the road.

Finally, there is the issue of autonomous vehicles sharing the road with human drivers. Our study of crashes on public roads involving Google's self-driving cars shows that even high-performing self-driving vehicles will still be struck by vehicles driven by humans.[18] We reviewed 19 crashes involving Google self-driving cars traveling in autonomous mode. In most of the incidents, the Google car was rear-ended by another vehicle.

Other opportunities to reduce crash deaths and injuries

Our work at IIHS and HLDI is guided by a rubric known as the Haddon matrix. Developed by William Haddon Jr., the nation's first highway safety chief and president of IIHS from 1969 to 1985, the matrix reminds public health practitioners and policymakers that there are often multiple opportunities to treat a public health problem such as motor vehicle crashes.

Improvements in vehicle safety have been effective in reducing crash deaths in recent decades, and increasing automation is the next logical step in those efforts. However, it would be a mistake to focus on those opportunities to the exclusion of proven countermeasures. Lower speed limits, strict enforcement of seat belt laws and prohibitions on alcohol-impaired driving, and safer road designs are just some of the tools that could be used to reduce the toll from crashes while we wait for the benefits of driving automation.

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