Status Report

Insurance Institute for Highway Safety | Highway Loss Data Institute

Knowledge gap

New studies highlight driver confusion about automated systems

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Tesla Model 3 Autopilot

Vehicles are getting increasingly sophisticated, with more and more of them able to stay in a lane and maintain a set speed and following distance with minimal driver input. But this kind of automation has limitations that can be tricky for drivers to grasp, and two new IIHS studies highlight misperceptions or gaps in drivers' understanding.

One study revealed how the names manufacturers use for these systems can send the wrong messages to drivers regarding how attentive they should be. Another found that drivers don't always understand important information communicated by system displays.

"Current levels of automation could potentially improve safety," IIHS President David Harkey says. "However, unless drivers have a certain amount of knowledge and comprehension, these new features also have the potential to create new risks."

The automation available in vehicles available for purchase today is considered Level 1 or 2, which applies to systems that can perform one or more parts of the driving task under supervision of the driver. An example of a Level 1 system is lane centering, in which lateral control of the vehicle is automated, or adaptive cruise control, in which longitudinal control — i.e. speed and following distance — is automated. Systems that can perform both of those functions simultaneously are Level 2 systems.

These systems are a far cry from Level 5 automation, in which the entire driving task can be performed without input from a human under all conditions.

System names

Despite the limitations of today's systems, some of their names seem to overpromise when it comes to the degree to which the driver can shift their attention away from the road. One name in particular — Autopilot — signals to drivers that they can turn their thoughts and their eyes elsewhere, an IIHS survey found.

For the survey, more than 2,000 drivers were asked about five Level 2 system names currently on the market. The names were Autopilot (used by Tesla), Traffic Jam Assist (Audi and Acura), Super Cruise (Cadillac), Driving Assistant Plus (BMW) and ProPilot Assist (Nissan). Participants were told the names of the systems but not the vehicle brands associated with them and weren't given any other information about the systems.

None of these systems reliably manage lane-keeping and speed control in all situations (see *Status Report*, Aug. 7, 2018). All of them require drivers to remain attentive, and all but Super Cruise warn the driver if hands aren't detected on the wheel. Super Cruise instead uses a camera to monitor the driver's gaze and will issue a warning if the driver isn't looking forward.

Each participant answered questions about two of the systems chosen at random. They were asked whether particular behaviors were safe while using that technology.

When asked whether it would be safe to take one's hands off the wheel while using the technology, 48 percent of people asked about Autopilot said they thought it would be, compared with 33 percent or fewer for the other systems. Autopilot also had substantially greater proportions of people who thought it would be safe to look at scenery, read a book, talk on a cellphone or text. Six percent thought it would be OK to take a nap while using Autopilot, compared with 3 percent for the other systems.

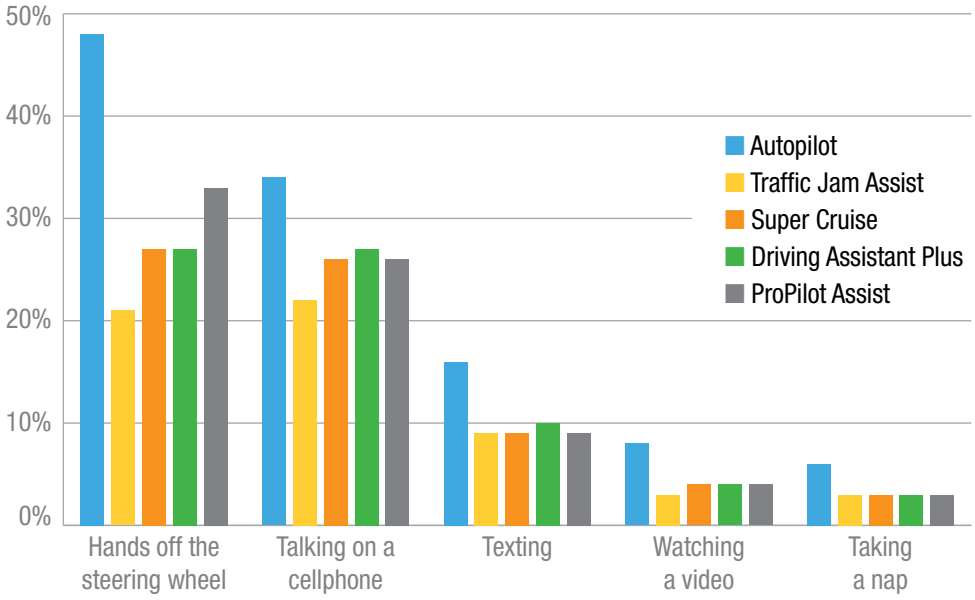
At least a few Tesla owners have been misusing Autopilot in this way, with fatal results.

In March, a Tesla driver crashed into the side of a tractor-trailer in Florida. The Model 3 went completely under the truck, shearing off the Model 3's roof and killing its driver. A preliminary investigation by the National Transportation Safety Board found that Autopilot was engaged at the time of the crash, and the driver's hands were not detected on the steering wheel.

The same was true in the crash of a Tesla Model X in California one year before (see *Status Report*, Aug. 7, 2018) and a 2016 Florida crash of a Model S that also involved the side of a tractor-trailer.

"Tesla's user manual says clearly that the Autopilot's steering function is a 'hands-on feature,' but that message clearly hasn't reached everybody," Harkey says. "Manufacturers should consider what message the names of their systems send to people."

Percent of drivers who considered behaviors safe while Level 2 system is in operation



Instrument cluster information

If a system name is one of the first ways a driver learns about a feature, another source of information is the instrument cluster. Displays are important because they tell a driver how a system is responding to situations or when a system is temporarily inactive. For example, a lead vehicle may disappear from the display when that vehicle is cresting a hill and no longer detected by the system's radar. Similarly, lane lines may disappear from the display when the lane markings on the road are no longer visible to the system's cameras.

The second recent IIHS study looked at whether drivers understand this information from the display of a 2017 Mercedes-Benz E-Class with the Drive Pilot system. The E-Class display is typical of displays from other automakers.

Eighty volunteers viewed videos recorded from the driver's perspective behind the wheel of the E-Class. The participants were asked about the operating status of the adaptive cruise control and lane-centering features. If the features were inactive, the participants were asked to explain why. Half of the participants first received some training in the form of a brief orientation about the instrument cluster icons pertaining to the two systems.

Understanding these displays is important because automated systems can behave unexpectedly (see *Status Report*, Aug. 7, 2018) and changing circumstances may require the driver to intervene.

In the study, certain key pieces of information eluded many of the participants. While almost everyone was able to understand when adaptive cruise control had adjusted the vehicle speed or detected another vehicle ahead, most participants, regardless of whether they received the training, struggled to understand what was happening when the system didn't detect a vehicle ahead because it was initially beyond the range of detection.

Most of the people who didn't »

Levels of driving automation (developed by SAE International)

Level 0	The human driver does everything.	
Level 1	An automated system can assist the human driver in conducting one part of the driving task.	Available on vehicles that can be purchased today
Level 2	An automated system can assist the driver with multiple parts of the driving task. The driver must continue to monitor the driving environment and be actively engaged.	
Level 3	An automated system conducts all of the driving task without driver engagement and monitors the driving environment, but the human driver must stand by to intervene in response to a system failure or request from the system to take over.	
Level 4	An automated system can conduct the entire driving task without driver input but only in certain conditions (e.g., limited to 25 mph) or places (e.g., a city center).	
Level 5	An automated system can perform the entire driving task without driver input under all conditions.	

2017 Mercedes-Benz E-Class with Drive Pilot dash display

Adaptive cruise control indicator

This car icon is green when a lead vehicle is detected and gray when no lead vehicle is detected. The leading car depicted in the center means the same thing, but drivers can choose to have information about other vehicle systems displayed there instead.

Lane-centering indicator

This steering wheel icon is green when the lane-centering system is actively controlling steering and gray when it is inactive due to road conditions. From the green state, it sometimes briefly flashes yellow when transitioning from active to inactive.

(« *from p. 3)* receive training also struggled to identify when lane centering was inactive. In the training group, many people got that right. However, even in that group, participants often couldn't explain why the system was temporarily inactive.

"If your Level 2 system fails to detect a vehicle ahead because of a hill or curve, you need to be ready to brake. Likewise, when lane centering does not work because of a lack of lane lines, you need to steer," says Harkey. "If people aren't understanding when those lapses occur, manufacturers should find a better way of alerting them."

Some systems use audible alerts in those situations in addition to visual signals. That may help, but drivers often find audible alerts annoying. Another option is making the pertinent visual signal more obvious and understandable.

Although systems ideally should be intuitive, providing an orientation at the dealership could also help. The study showed that interface-specific training helped drivers notice changes in lane-centering activity and use the correct icons to determine system status.

For copies of "What's in a name? Drivers' perceptions of the use of five SAE Level 2 driving automation systems," by E.R. Teoh and "Effects of training and interface content on Level 2 driving automation interface usability," by A.S. Mueller et al., email StatusReport@iihs.org. ■

Is automation used where it's intended?

The automated systems available in vehicles today are designed to be used only on certain types of roads. A recent study by researchers from IIHS and the Massachusetts Institute of Technology's AgeLab found that, for the most part, drivers use the technology where it was intended, though they may not be using it enough to have a measurable effect on safety, and some individuals may be using the systems on roads they weren't designed for.

For the study, a project of the Advanced Vehicle Technology Consortium, volunteer drivers spent four weeks driving either a Range Rover Evoque with adaptive cruise control or a Volvo S90 with adaptive cruise control and Pilot Assist, a Level 2 system that enhances the adaptive cruise control with lane centering. During the study, the S90 underwent a software update that improved the lane centering, so the researchers looked separately at those who drove the S90 before the update and those who drove it after.

Like most driving automation in currently available vehicles, these systems are meant to be used on interstates and other freeways.

In the study, 40 percent of interstate and other freeway miles of Evoque drivers were driven using adaptive cruise control. Before the software update, 11 percent of interstate/freeway miles in the S90 were driven with adaptive cruise control alone and another 11 percent were driven with the Level 2 Pilot Assist system. After the update, those numbers were 8 percent and 20 percent, respectively.

"Driving automation could reduce crashes by eliminating some of the potential for human error," says IIHS Senior Research Scientist Ian Reagan. "But given the low use of the systems and the fact that most vehicles on the road today still don't have these features, we don't expect to see these crash reductions any time soon."

Far smaller percentages of miles traveled on nonfreeway roads in the study involved automation.

Vehicle manuals often give ambiguous instructions about where to use these types of systems, sometimes saying only that they are for "highway use." It's not always clear if nonfreeway arterials should be considered "highways" or not.

On the one hand, these roads often have higher speed limits and free-flowing traffic, and so in that sense they fit the usual criteria for Level 1 or 2 systems. However, they often have intersections, and many manuals advise against using the systems on roads with intersections. That's because the systems don't react to traffic lights or stop signs and can have trouble detecting stopped vehicles ahead and avoiding cross traffic. They also can have trouble staying within the lane through intersections.

The Evoque's adaptive cruise control was on for 7 percent of nonfreeway principal arterial miles. Eleven percent of the post-update S90 nonfreeway principal arterial miles involved Pilot Assist.

There was wide variation in use of the systems, with some drivers not using them at all and some using them a lot. One Evoque driver drove 41 percent of nonfreeway principal arterial miles with adaptive cruise control, and one post-update S90 driver used Pilot Assist for 30 percent.

For a copy of "Measuring adult drivers' use of Level 1 and 2 driving automation by roadway functional class" by I.J. Reagan, email StatusReport@iihs.org. ■

Ford F-150 repair costs remain steady despite use of aluminum

Ford's switch to aluminum for the body of the F-150 pickup hasn't resulted in higher repair costs, in part because the company is pricing the aluminum parts lower than steel ones, HLDI analysts have found. However, while the cost for repairs hasn't risen, the time required for them appears to have gone up, and that could lead to higher insurance costs.

When Ford began building its iconic truck out of aluminum instead of steel, consumers had questions about the effect it would have on safety and their wallets. At the time, IIHS high-speed crash tests showed safety wasn't adversely affected, while a separate experiment showed repair costs were. Damage to an aluminum-body F-150 from a low-speed crash turned out to be more expensive to fix than damage to an older, steel-body F-150 put through the same crash (see "Pricier repairs for aluminum F-150 than steel model in fender-benders," July 30, 2015).

Now HLDI has an update based on real-world claims data. In the four years since Ford introduced the aluminum-body truck, the change in material hasn't resulted in more costly insurance claims. That's likely a result of Ford's efforts to hold down the price of aluminum replacement parts and simplify repairs. At the same time, Ford has raised the prices of steel parts for older models.

HLDI analysts compared average loss payment per claim, or claim severity, under collision insurance, which covers damage to an at-fault driver's vehicle, for the aluminum-body 2015-16 F-150 and the steel-body 2014 model. They also compared 2015 and 2016 models of the Chevrolet Silverado 1500, GMC Sierra 1500 and Ram 1500 with their 2014 counterparts. Those pickups have kept their steel bodies.

Claim severity for each of the 2015 and 2016 models was higher than for the corresponding 2014 models, but the increase was smallest for the F-150. It rose less than 1 percent for 2015 models, compared with 5-7 percent for the other pickups. For the 2016 F-150, severity rose 4 percent over the 2014 model, while other 2016 models had claim severities 12-21 percent above their 2014 model year results.

Ford F-150

These rising claim severities are consistent with data HLDI has collected on claims across all vehicles, which show that the average loss payment per claim has gone up in recent years. Given that the F-150's claim severity didn't rise as much as the severities for other pickups, the 4 percent increase for the 2016 model year is likely unrelated to the use of aluminum.

This result contrasts with an earlier HLDI study that looked at aluminum use in luxury vehicles and found it was associated with higher collision claim severity.

When Ford switched to aluminum for the F-150's body in a bid to shed pounds and improve fuel economy, it took measures to ensure repair costs wouldn't rise. To help make repairs simpler with lower labor costs, the company used a modular design. Ford also offered dealerships and body shops the chance to buy tools for repairing aluminum-body vehicles at a discount. Finally, it has lowered prices on many parts for the 2015-16 F-150 while raising prices for the same parts for the 2014 steel model.

However, despite the findings on claim severity, HLDI uncovered some evidence of other, hidden costs. It takes longer for loss information to accumulate for F-150 claims, and that is likely an indication that repairs are taking longer. That means F-150 owners have to make do for longer without their vehicles, and there are additional costs to insurers for rental vehicles. Although these delays decreased in the 2016 and 2017 model years, repairs are still taking longer for the aluminum truck than for the steel F-150 and for other models.

In addition, HLDI found that collision claim frequency is 7 percent higher for the aluminum F-150 compared with control vehicles. It's not clear what has caused that increase, but the aluminum-body truck may be more easily damaged than the steel one.

"Ford has worked to keep repair costs down for its aluminum-body truck," says HLDI Senior Vice President Matt Moore. "But unless other manufacturers take the same steps, there's no guarantee that these results will hold true for future aluminum-body vehicles from other manufacturers. In addition, the higher claim rates are concerning." ■

Vehicle manufacturers make strides on LATCH ease of use

Nearly three-quarters of 2019 vehicles have LATCH hardware that rates good or acceptable for ease of use, as automakers continue making improvements that help parents and caregivers properly install child restraints.

The results mark a shift from 2015, when IIHS launched its LATCH ease-of-use ratings. At that time, a majority of new vehicles rated poor or marginal.

Today, 23 vehicles earn the top rating of good+, 31 are rated good, and 87 rate acceptable. Forty-nine vehicles are marginal, and only four earn a poor rating. Among automakers, Toyota and Subaru are standouts for LATCH ease of use, while U.S. automakers lag behind. Installation in pickups is trickier than in other types of vehicles.

A properly installed, age-appropriate child restraint can protect a child much better in a crash than a seat belt alone. LATCH, which stands for Lower Anchors and Tethers for Children, is intended to make child restraint installation easier. Child restraints installed with LATCH are more likely to be put in correctly than restraints installed using the vehicle seat belt, IIHS research has shown.

But even with LATCH, installation isn't always simple, and errors are common. The Institute's ratings are based on ease-of-use criteria that have been shown to minimize mistakes.

Toyota and Subaru stand out for LATCH ease of use. They're tied for the most vehicles with the highest rating of good+.

"With child restraints, a good, tight installation is critical but can be difficult to achieve," says Jessica Jermakian, an IIHS senior research engineer. "Thanks to these recent improvements in vehicle LATCH hardware, we expect more children will be riding in correctly installed seats."

In the IIHS ratings system, LATCH hardware is considered good if it meets the following criteria:

- The lower anchors are no more than ¾ inch deep within the seat bight — the place where the seatback meets the bottom seat cushion — or slightly deeper if there is open access around them.
- The lower anchors are easy to maneuver around. This is defined as having a clearance angle greater than 54 degrees.
- The force required to attach a standardized tool representing a child seat connector to the lower anchors is less than 40 pounds.
- Tether anchors are on the vehicle's rear deck or in the middle of the seatback. They shouldn't be at the very bottom of the seatback, under the seat, on the ceiling or on the floor.
- The area where the tether anchor is found doesn't have any other hardware that could be confused for the tether anchor. If other hardware is present, then the tether anchor must have a clear label located within 3 inches of it.

To earn a good rating, two LATCH positions in the second row must meet all five criteria, and a third tether anchor must meet both tether criteria.

The good+ rating is for vehicles that

Subaru Crosstrek Hybrid

2019 vehicles with good+ and good LATCH ratings

Listed rating is the highest available for the most popular seat covering within the vehicle class.

Good+

Acura RDX
Audi Q7
Honda Accord
Honda Insight
Honda Odyssey
Jeep Cherokee
Lexus RX
Lexus UX
Mazda 3 hatchback
Mazda 3 sedan
Mazda 6
Subaru Ascent
Subaru Crosstrek
Subaru Forester
Subaru Impreza sedan
Subaru Impreza wagon
Subaru Legacy
Subaru Outback
Toyota Avalon
Toyota Camry
Toyota Corolla hatchback
Toyota Prius
Toyota RAV4

Good

Audi A4
Audi A4 Allroad
Audi A5 Coupe
Audi A5 Sportback
Audi A6
Audi e-tron
Audi Q5
Audi Q8
BMW 2 series
BMW 3 series
BMW X5
Hyundai Nexo
Lexus ES
Lexus IS
Lexus NX
Lexus RC
Mercedes-Benz C-Class
Mercedes-Benz E-Class
Mercedes-Benz GLS-Class
Mercedes-Benz GLE-Class
Mitsubishi Mirage
Nissan Altima
Nissan Kicks
Nissan Maxima
Nissan Rogue
Nissan Sentra
Toyota C-HR
Toyota Highlander
Toyota Prius Prime
Volkswagen GTI
Volkswagen Passat

Pickups like this one (shown with head restraints removed) typically require child seat tethers to be fed through a loop at the top of the vehicle seat (left) and then attached to a loop or anchor above an adjacent seating position. This complexity makes it hard for pickups to earn good LATCH ratings.

meet the criteria for a good rating and provide additional LATCH-equipped seating positions. For a two-row vehicle, that means having a third good or acceptable LATCH seating position. The third position may use either dedicated anchors or anchors borrowed from other positions. In many vehicles that have lower anchors in the second-row outboard seating positions, LATCH can be used in the center position by "borrowing" one anchor from each side. Some vehicles have one dedicated anchor for the center seat and rely on a borrowed anchor for the other side.

For a three-row vehicle to earn a good+ rating, it must have one additional good or acceptable LATCH position (without borrowing) and tether anchors in all rear seating positions. The additional tether anchors must meet at least one of the two tether anchor criteria. If the vehicle has a second-row center seating position, it must have good or acceptable LATCH there (with or without borrowing).

Of all the manufacturers, Subaru and Toyota are tied for the most good+ ratings. Seven of Subaru's eight vehicles earn the designation. Of the 25 rated vehicles from Toyota and its luxury Lexus brand, seven earn a good+ rating and another seven earn a good rating. Neither Ford nor General Motors have a single model with a good or good+ rating. In Fiat Chrysler's lineup, one vehicle — the Jeep Cherokee — has a good+ designation.

No pickups earn a rating higher than acceptable, and 14 out of 20 are rated marginal. The main problem is the tether anchors. Because the rear seat of a pickup is right up against the back wall of the cab, there aren't many options for where to locate them. In most pickups, the tether must be routed through a loop near the head restraint and then attached to another loop or anchor, typically in an adjacent seating position.

"When we've done studies observing people installing child restraints, we've seen that the tether anchors in pickups are a real point of confusion," Jermakian says. "We're continuing to work with manufacturers to come up with solutions to this issue." ■

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Inquiries/print subscriptions:
StatusReport@iihs.org

Editor: Sarah Karush
Art Director: Steve Ewens
Photographers: Steve Ewens, Craig Garrett, Dan Purdy

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IIHS is an independent, nonprofit scientific and educational organization dedicated to reducing the losses — deaths, injuries and property damage — from motor vehicle crashes.

HLDI shares and supports this mission through scientific studies of insurance data representing the human and economic losses resulting from the ownership and operation of different types of vehicles and by publishing insurance loss results by vehicle make and model.

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