Driver Training for Advanced Driver Assistance Systems

Who Needs It, Who Wants It, and Will It Make a Difference?

Photo: State Farm

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Above: Studies of reverse driving crashes in cars equipped with backup cameras found that, instead of supplementing regular procedure of checking mirrors and looking over their shoulders, many drivers were using the cameras to trade one blind spot for another.

In 2008, 292 people were killed and another 18,000 injured when motorists attempted the most dangerous driving stunt permitted outside of a closed-course test track: backing up. Children under age five, who comprise 44% of all backup fatalities, were most likely to pay the price when things went wrong.

From the perspective of the engineer, an obvious contributor to these tragedies was that drivers could not see what was behind their vehicle. From the perspective of the engineer, the solution to the problem could not seem any clearer. First proposed by Buick in 1956, rearview cameras began to appear in 2001. After some delay, the National Highway Traffic Safety Administration issued its final rule requiring that all cars be outfitted with cameras by 2018.

With more and more camera-equipped cars rolling off the assembly line, the industry prepared for a dramatic decline in backup fatalities—but this didn't happen. In 2017, Jessica Cicchino, a researcher at the Insurance Institute for Highway Safety (IIHS), conducted a study that compared the safety records of cars with and without rearview cameras (*1*). Cicchino found that, overall, cars with cameras were 17% less likely to be involved in a police-reported backup crash. *Seventeen percent*—far from the hoped-for 100%.

With the entire perimeter of a vehicle now within view, what could possibly be going wrong? Another team of researchers at IIHS, led by David Kidd, already had identified one possible issue. In their observations of drivers using rearview cameras, Kidd's team found that, instead of using the camera to supplement their scans in the manner envisioned by engineers, many drivers were using the cameras as a *substitute* for a more complete scan. In other words, drivers simply looked at the rearview scene and proceeded if the rear looked clear. The traditional over-the-shoulder glances were now less frequent. What drivers seemed to miss is that the most common sort of backup crash happens when a child comes running from the *side* of the car. Kidd found that many drivers were using the cameras to trade one blind spot for different blind spots (*2–3*).

Blind Trust

Such encounters with rearview cameras are hardly the only example of how things can go wrong when drivers use the technologies now being deployed in many late-model vehicles. The newspaper headlines tell similar stories about other car automation systems: "Tesla's Autopilot keeps crashing into parked cars. Here's why;" "Don't blindly trust your car's collision avoidance system;" "As automatic braking becomes more common in cars, so do driver complaints;" and "Thanks autopilot: Cops stop Tesla whose driver appears asleep and drunk" (*4–7*).

If one thing has been learned from early experience with these systems, it is that safety engineering alone is unlikely to solve these problems. Until driving is fully autonomous, advanced driver-assistance systems must rely on the active and intelligent participation of human drivers. Drivers and technology need to work together as a team, each making a unique contribution and helping to overcome the limitations of the other. For now, the dream of pushing a button, directing one's attention elsewhere, and assuming that all will go to plan remains a dream.

The industry has begun to reengineer the vehicles. Now it is time to reengineer the minds of the drivers. But how many people would be willing to sit through training for something that they have been doing their entire adult lives? And would driver training really make a difference in safety outcomes? Research is under way to answer these very questions.

Do Drivers Really Need Training?

To many, sitting through a training course on how to push a few buttons on a steering wheel or dashboard seems unnecessary. After all, since the 1980s, designers have focused on creating intuitive, "user-friendly" interfaces. Why can't we provide drivers with automated support for familiar driving tasks and simply tell them that the technology isn't perfect: that they need to keep paying attention, and if anything looks strange, to take over and drive? What else is there to know?

One trap that drivers already fall into is a belief that the automation is more capable than it really is. It is easy to imagine that computers have the same common-sense understanding of the world as humans do, but nothing could be further from the truth. Situations that seem trivial—that humans take for granted—often are beyond the capabilities of the most sophisticated automation system.

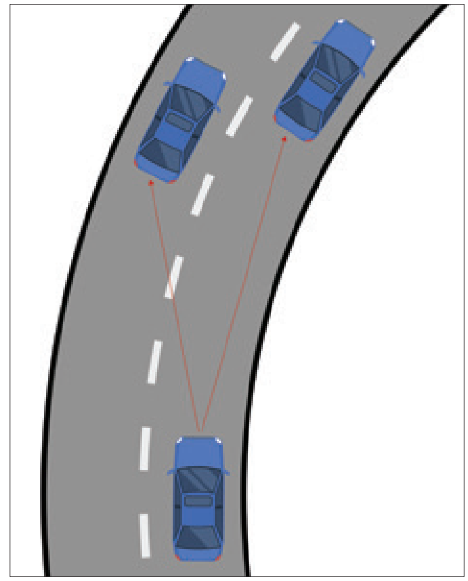

FIGURE 1 Optical tricks easily processed by the human brain may confuse automated systems.

Suppose your lane-keeping system is engaged and your car is tracking another car in front of you. If you round a sharp corner, you will likely pay little attention to the fact that two cars now appear in your windshield scene. The car you are following appears on one side of your windshield and a car that is driving in the adjacent lane appears on the other side of your windshield—an optical feature of curves that the human brain can easily handle (see Figure 1, above). To a computer vision program, however, it is just an array of shapes and colors. Could the automation confuse the two cars? Could it try to follow the other car and drift into the other lane? If yet another car comes up beside you in that lane, would your collision-avoidance system scream at you or take over if that car tried to change lanes? Would the lane-keeping system fight for control with the collision-avoidance system? These are not easy questions to answer.

Photo: Roberto Nickson/Unsplash

Until fully automated driving is possible, advanced driver-assistance systems must rely on the participation of human drivers. This may require a new type of driver training.

Photo: David Emrich/Unsplash

Drivers often underestimate the role of human passengers in their driving decisions.

Accompanying the common misunderstandings about how systems work often is an overconfidence in understanding how the systems work. Confused about what computers can and cannot do—and what we know and don't know about them—we tend to trust more than we inquire. Study after study shows how people tend to bow to the authority of computing systems they do not understand—even when it becomes apparent that the systems don't work all that well. In our minds, it is as if computers are endowed with superior intellect as soon as they roll off an assembly line.

Not only do we overestimate what computers can do for us, we also tend to underestimate what human passengers do for us. People seldom are aware of the subtle feedback they get when they work in the presence of other humans. Invite someone to sit in the front passenger seat of your car. You likely will observe them chime in with a little help. They may clear their throats, point things out, tense up, roll their eyes, and make snarky comments—all of which serve to direct our attention to things that we might have missed. For whatever reason, however, few of these feedback cues are incorporated into driver automation systems. The industry tends to design strong, silent automation interfaces that don't offer many clues about how they are classifying what they sense or what they plan to do next.

All the while, these systems harness the power to intervene in our driving by nudging our steering wheel or slamming on the brakes.

Who Wants It?

Just because we think that training is needed does not mean that people will want it. Instruction manuals are known to receive scant attention from product users and driver manuals are no exception. The openness of most people to receiving "frontal lectures," especially about already-familiar topics, isn't much better.

Driver automation may be an exception, however. New car buyers seem to understand that there is something special about vehicle automation and may be more willing to learn more about it. A revealing study done by State Farm found that 51% of all drivers surveyed consider training very important, while another 24% consider it somewhat important (*8*). A similar study conducted by Hillary Abraham found that 68% of all new car buyers received between zero and 29 minutes of instruction on their new car, and more than half of them expressed a desire for more instruction (*9*). It could be that beneath the desire for vehicle automation training is the reassurance that the *other drivers* will get it, too.

The other stakeholders in this emerging industry are insurance companies. If training can help avoid crashes, then that means fewer claims and fewer payouts. But does training really help?

Will Driver Training Make a Difference?

Training takes time and costs money. It is fair to ask whether the investment would yield returns in the form of improved safety outcomes. This question has been considered before, with high school driver education programs. Years ago, a driver education course was a standard part of almost every high school curriculum. Students learned in the classroom and then spent time behind the wheel with a driving instructor.

Over the past decade, however, these programs have all but disappeared. School budget cuts receive some of the blame, while an increasing emphasis on preparation for college entrance exams claimed another portion of students' time and schools' money. A series of studies appeared to demonstrate that high school students who completed an in-school driver education program crashed no less frequently than students who did not get the training (*10*).

As training for the old kind of driving was eliminated, a new kind of driving began to emerge. Today, vehicle automation and smartphones lure us into distraction. Work and life schedules are busier, and we are seeing a corresponding increase in speeding and driver aggression.

Many have argued that older driver education programs failed to achieve a reduction in crashes simply because they did not teach students the right things. Instead of simply logging hours behind the wheel, some argued that students should be taught core cognitive skills such as hazard anticipation and perception. Researchers in the automotive industry are already looking at the effectiveness of training programs focused on vehicle automation.

A group at BMW investigated what would happen if drivers followed the oft-given advice to read the manual. They found that requiring study participants to read the manual resulted not only in improved understanding of the automation system but also in driver interaction with the equipment, as judged by the experimenters. Well aware of the challenges of getting drivers to read manuals outside of an experimental setting, the BMW group found that even greater gains were made when training took the form of video or an interactive tutorial—or, even better, a driving simulator.

Taking the simulation idea to its limit, Madi Ebnali of the University of Buffalo is conducting a study on the use of immersive virtual reality to provide trainers and drivers with low-cost, engaging simulated driving experiences.

A study by Alexandria Noble at Virginia Tech Transportation Institute found that the greatest improvements in driver attitudes and behavior occurred when trainees were provided with test-track driving experience (*11*). Noble and colleagues found that continued practice with the automation helped reinforce what each participant had learned during the training episode. The problem is that test tracks and long training courses are not a viable option for all drivers, and it isn't possible to have a driving instructor or human-factors researcher ride along with a new car owner for several months after the purchase. Or is it?

Photo: Clément/Flickr

As with traditional driving instruction, a solid understanding of the concepts of automation is most effective—not just knowing which buttons to press.

In the Netherlands, Anika Boelhouwer is developing an in-vehicle tutor that plays the role of a driving instructor (*12*). Naturally wanting to avoid installing a digital "backseat driver" in cars, Boelhouwer first conducted an observational study of driving instructors, professionals who are trained to help a driver—without driving them crazy. Every good instructor knows that there is a subtle art to knowing when to speak up and when to remain silent.

Realizing the importance of what is said to the driver during a lesson, the BMW researchers are examining how real-time appraisals of driver performance affect their learning trajectory. Lending encouragement to other in-vehicle support efforts, the study done by Abraham and others at the Massachusetts Institute of Technology found that 25% of new car buyers welcomed instruction provided by the car itself (*9*).

What we teach also matters. Studies have shown us that simply memorizing button-pushing procedures is not enough. Taking the time to understand how the automation works pays off when users are presented with real-life situations that may differ from the ones they practiced during training. Understanding the foundations that underpin the familiar button-pushing procedures also helps users to remember these procedures if they have not exercised them in a while or even to come up with alternative ways of accomplishing the same task.

Martin Krampell and colleagues at Volvo are already studying the effects of teaching conceptual models of how automation works and have found that drivers who are given a deeper, more-conceptual understanding of the automation also are more likely to retake control of the vehicle during critical situations (*13*).

Conclusion

Today, partial autonomy is being deployed in cars en masse. Advanced driver assistance systems rapidly are becoming standard features for all light-duty cars and trucks. Studies of behind-the-wheel smartphone use assure us that this behavior—now responsible for as many as one-fourth of all crashes—shows little sign of moderation. Further, driving as a task

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is growing more and more complex each year, without a reciprocal level of understanding from the public.

But won't drivers eventually figure it out or use their common-sense intuitions, proceed cautiously, and learn as they go? That is unlikely because, as we have seen, our common-sense intuitions often are spectacularly wrong when they are placed in front of modern technology. When crashes happen, rather than acknowledging this situation, we often distance ourselves by dismissing those involved as bad actors who possess poor judgment, who lack responsibility or basic common sense, or who are simply members of a problematic generational cohort.

There is more at stake than overall crash statistics here. How will these issues play out during litigation? It is important to realize that the problems with human–automation interaction are being thoroughly documented in scientific studies and that equally thorough solutions have yet to be identified. More research is needed to help answer these and other questions as hundreds of millions of drivers participate in the largest-scale experiment ever conducted on the nation's roadways.

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