



Auto Safety Report

CONSUMER CLARITY AND
SAFETY FOR TODAY'S
ADVANCED DRIVER SYSTEMS

INTELLIGENCE FOR CONSUMER GOOD

Auto Safety Report

Consumer Clarity and Safety for
Today's Advanced Driver Systems

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FIRST EDITION

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CR Consumer
Reports™

Introduction

We are at the dawn of the biggest technological revolution the auto industry and consumers will experience since the motor vehicle was introduced more than a century ago.

Cars are far more reliable, efficient, and luxurious than at any time before. And they're much safer, too. But in coming years, with advancing sensor technology and greater onboard computing power, the automobile is poised to take even greater leaps in enhanced intelligence, safety, and convenience for consumers.

This technological revolution is being guided by the continuing introduction of advanced driver assistance systems which, separately or when combined, have the potential to make car travel easier and safer, either by increasing the driver's field of awareness or by assisting with—and at times taking over—driving tasks.

Advanced driver assistance systems, or ADAS, are technologies that have the potential to enhance safety or convenience, depending on how they are implemented. These advanced assistance features include visual aids, driving intervention systems, and higher levels of automation.

While the idea of "self-driving" cars soaks up most of the public's awe and attention, that is only part of the suite of technology that, over time, will revolutionize the experience of driving and car travel in subtle and pronounced ways. Today's technologies, such as backup cameras, electronic stability control, and automatic emergency braking, are morphing into greater advancements that inevitably will lead to partially and fully automated vehicles. At the same time, it is those technologies of today that can have the greatest benefits for consumers over the coming decade or two, as we wait for partial and full automation to be perfected.

This advancing revolution can't come soon enough for Americans who rely heavily upon their vehicles to go about their daily lives. Altogether, U.S. consumers drive roughly 3 trillion miles a year and pay for almost \$1 billion worth of fuel each day.

The human costs of car travel—which had been historically trending downward—remain unacceptably high, and fatalities on roads are now on the rise. Each year, there are more than 6 million crashes and 2 million injuries—and 37,461 deaths in 2016 alone—according to data from federal regulators.

Introduction (continued)

Whether ADAS technology advancement can help to reduce these devastating human losses, or relieve financial and environmental burdens, is still to be determined. The promise and success of such systems going forward—especially for partially and fully automated vehicles—will depend on how well automakers engineer and implement them, whether consumers embrace the technology, and what types of consumer protections governments establish for them.

Consumer Reports has prepared this report to offer insight and perspective into the promise and the reality of these advanced driver assistance systems. Our findings are based upon our extensive and proprietary consumer survey data; thousands of miles of CR's expert, hands-on road tests; and objective, independent analysis of vehicles that have these developing systems. The findings also draw from our deeply engaged experience of working with the industry and regulatory sectors and advocating on behalf of all consumers, especially where safety is concerned.

These new systems hold great opportunity for safety advances, but they are also quite complicated and can, we have found, at times confound consumers.

Our aim is to deliver fact-based and data-driven recommendations to the industry, its partners, and government regulators on how to best implement such technology based on CR's trusted relationship with consumers and well-earned agency with regulators. With our data and analysis, and your feedback and input, we hope to identify key issues and concerns that may require further research, action, and greater public awareness going forward.

Key Recommendations

The emerging era of the advanced driving assistance systems, including features associated with the terms “partially and fully autonomous vehicles,” presents new complexities and challenges when it comes to safety. Both the safety of the systems and consumer acceptance are based on multiple, interrelated variables; among them are trust, transparency, design, functionality, and performance.

Based on those and other considerations, Consumer Reports has identified the following opportunities to help ensure safety and accelerate consumer acceptance and adoption of these advanced driver assistance systems:

LABEL THEM RESPONSIBLY

The industry and regulators, along with consumer and safety groups, should work together to establish a clear, consistent, and accurate naming convention to help consumers fully understand what functions individual advanced driver assistance systems (ADAS) provide, and which ones they don't.

CLARIFY SAFETY VS. CONVENIENCE

The industry should differentiate between features specifically engineered to improve safety from those that merely make the task of driving easier. Consumer Reports suggests that a new “ADAS feature” classification—either labeled Safety or Convenience—should be adopted and welcomes further dialogue around this approach. Here's why this is necessary:

- ADAS safety features are warnings, visual aids, and emergency driving intervention systems. These safety features should be clearly designed and clearly marketed to consumers in order to maximize their built-in safety advantages and to convince drivers never to turn them off.
- ADAS convenience features are those that take over some driving functions (for example, adaptive cruise control or lane-centering assist) but require driver participation and vigilance. Though these systems can make driving easier, CR is concerned that some consumers will not stay as engaged with the road, and that can be hazardous to their safety. Convenience features should never be promoted as safety features, and their limitations should be acknowledged by automakers and clearly communicated to drivers. These features should include their own backup safety system or safe fallback mode to make up for driver inattention and/or confusion.

Key Recommendations (continued)

IMPLEMENT DRIVER MONITORING OR EQUIVALENT SYSTEMS

Automakers should develop and implement driver monitoring or other systems to ensure that ADAS convenience features do not pose risks to safe travel, and to more broadly protect all road users from human error. These monitoring systems should be effective and secure, and strictly adhere to privacy protection standards.

CLEAR AND EASY IS BEST

Most vehicle owners are very satisfied with their advanced driver assistance systems, but there are opportunities to increase the ubiquity of these features, too, and make the car and driver even safer as a result.

- Advanced driver assistance systems that are easy to understand and don't require drivers to change the way they drive tend to be more satisfying to owners. Satisfaction with most visual aids (for example, blind-spot warning systems) is significantly higher than with systems that attempt to assert control of the vehicle (such as lane-keeping assist). We found that drivers appreciate visual information, especially if it offers clear, unambiguous information where they can easily see it.
- False alerts are frustrating to the consumer. Some brands need to better assess and understand how often and in what conditions these false alerts occur. CR observed this kind of frustration with forward-collision warning systems in several brands. We also have identified opportunities to increase understanding and minimize unnecessary warnings from advanced driver assistance systems.

SAFETY TOO EARLY TO SAY

Partially autonomous systems are so new that it's not yet clear whether their application and practice constitutes a confirmed win for drivers. But we can already see that for these systems to be safe, drivers must fully understand and embrace their responsibilities behind the wheel. The capabilities and limitations of these systems must be clearly communicated, ideally with the vehicle only enabling them when it is safe to do so. In addition, a system's capabilities should never be hyped or oversold through marketing or through how it is named or described to shoppers.

Key Recommendations (continued)

In addition to the efforts we've outlined, the success of ADAS technologies requires transparency. Transparency matters, and it will be particularly critical in gaining consumer trust and in avoiding consumer confusion over and potential rejection of promising new safety technology.

Surveys from MIT, AAA, and Deloitte have shown that consumers are starting from a place of distrust when it comes to automated vehicle systems. Therefore, automakers should not simply claim that their vehicles are safe. Instead, automakers can earn consumer trust by building safe systems, being transparent about the steps they are taking to ensure their products are safe, and sharing the data that back up their safety-related efforts.

Automakers can earn consumer trust by building safe systems, being transparent about the steps they are taking to ensure their products are safe, and sharing the data that back up their safety-related efforts.

What would transparency look like in the real world? At the very least, it should include automakers submitting comprehensive assessments of the safety of all vehicles with automation Levels 2 and higher to the National Highway Traffic Safety Administration (NHTSA). Those assessments should include data and transparency on all issues critical to a safe, fair, and responsible marketplace, including all elements called out in NHTSA's 2017 self-assessment, as well as privacy, ethics, data sharing, and registration and third-party certification.

As automakers add automation systems, consumers will expect vehicle safety to improve. At the same time, if automakers fail to meet those expectations, there will be consequences. Automakers must be transparent about what their vehicles (and systems) can and can't do to help avoid consumer confusion. A lack of transparency will only ramp up consumer skepticism and could fuel a backlash when the inevitable crashes occur. Such a backlash could delay consumer acceptance of this critically needed technology for years or decades.



Consumer Reports and Safety Advances

Consumer Reports has evaluated cars for more than 80 years and employs one of the most robust and unique combinations of testing, research, and industry expertise. We buy and test about 60 vehicles per year, driving them a total of about 900,000 miles. We also collect and analyze reliability and satisfaction survey data from hundreds of thousands of our subscribers. These comprehensive consumer sentiments supplement and enhance our scientific analysis, evaluations, and ratings.

Here are some key moments in our long history of engagement with auto-safety concerns and advances:



Consumer Reports found that two-thirds of safety belts failed to meet even modest guidelines.

CR INSIGHTS AND ACTION

CR first tested safety belts in 1956 and found that two-thirds of them failed to meet even modest guidelines. The results prompted Consumer Reports, long an advocate of safety belts as standard equipment, to call for better belts and later, for federal standards that incorporated actual crash-testing.

MARKETPLACE RESULTS

We steered our readers to purchase cars that included this life-saving technology. A 1961 survey showed that 17 percent of our subscribers—vs. 3 percent of the general population—had cars with seat belts at the time.

CR INSIGHTS AND ACTION

Seat belts, airbags, antilock brakes, backup cameras, and electronic stability control (ESC) are just some of the life-saving devices that Consumer Reports has tested and advocated for their adoption by the auto industry. In the case of ESC, we were an early proponent, recognizing its ability to prevent rollover accidents, especially in SUVs, which had a greater propensity to tip up in sudden avoidance maneuvers. We made a bold decision to withhold our recommendation from any SUV that did not have stability control as standard on all of the vehicle's trim lines—not just on the more expensive trim lines.

MARKETPLACE RESULTS

Almost all manufacturers added this as a standard feature on their vehicles before the mandated 2012 deadline.



Consumer Reports champions anti-rollover technology



Consumer Reports and Safety Advances (continued)

CR INSIGHTS AND ACTION

CR sought rules requiring rearview cameras in all vehicles. We measured every vehicle's blind spot to spread awareness to caregivers, and we were key players in a lawsuit that ultimately forced the government to move forward and implement the new law.



A win on rearview cameras

MARKETPLACE RESULTS

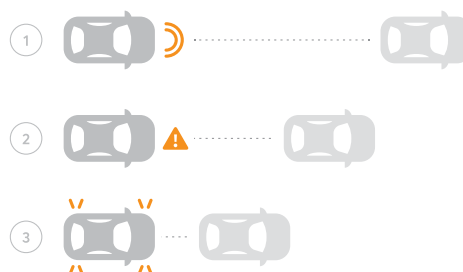
We were successful in compelling the government to issue rules requiring rearview cameras in all vehicles—a critical step in mitigating the tragedy of parents accidentally backing over their young children. As of May 2018, all new vehicles will be required to have a camera installed as a standard feature.

WHAT CR IS CURRENTLY ADVOCATING

CR has always been at the forefront of advocating for proven safety features, and the latest one we're championing is automatic emergency braking (AEB) with forward-collision warning (FCW). In 2016 NHTSA announced a voluntary agreement among the major automakers to make AEB standard by 2022. We will continue to monitor—and reward—vehicles in our ratings that make high- and low-speed AEB standard.

We are championing a set of basic principles around ADAS and automated driving systems with Level 2 or higher automation features.

- As automated vehicles reach market and improve consumer mobility—particularly for seniors, underserved populations, and individuals with disabilities—they must be closely monitored and evaluated to make certain they are safe.
- To support automotive innovation and protect the potential benefits of automation for consumer safety, any accelerated deployment of automation features should be guided by sensible, binding measures to protect consumers against any new hazards.
- And because it is not clear what the actual safety impacts will be as companies introduce automated driving systems, automakers must be guided by transparency, including providing detailed data that demonstrate the systems' safety benefits to consumers as well as to state and federal safety regulators.



NHTSA in 2016 announced a voluntary agreement among the major automakers to make AEB standard by 2022.

State of Advanced Driver Assistance Systems

Consumer Reports strongly supports the development and adoption of new vehicle safety technologies, particularly at a time when crash fatalities have been back on the rise for two consecutive years, according to federal data. But new features must be carefully implemented and clearly explained to car owners. Consumer perspectives should be sought and respected to assure this new technology will be accepted in the marketplace.

What Is ADAS Today?

There is still a lot more that can be done to protect car occupants, pedestrians, and bicyclists, and CR will continue to push for progress to ensure safety when crashes do happen. But the technology suite getting the greatest attention today is the one that can step in during an emergency or help with, or even take over, the driving task.

The levels of autonomy have been subject to various interpretations and much debate at times. Fortunately, the Society of Automotive Engineers (SAE) has established a guide to autonomy levels, which has become accepted by both the industry and NHTSA, the government agency responsible for vehicle safety. Two critical differentiators among these levels is determining who is in control of the car at any point in time—the human driver or the software—and whether or not the driver needs to remain alert, ready to resume control of the vehicle.

SAE Levels of Automation		Execution of Steering and Acceleration/Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)
5	Full Automation	System	System	System	All driving modes
4	High Automation	System	System	System	Some driving modes
3	Conditional Automation	System	System	Human driver	Some driving modes
2	Partial Automation	System	Human driver	Human driver	Some driving modes
1	Driver Assistance	Human driver and system	Human driver	Human driver	Some driving modes
0	No Automation	Human driver	Human driver	Human driver	N/A

■ Features available in marketplace

Source: Society of Automotive Engineers



State of Advanced Driver Assistance Systems (continued)

Still, there's a lot of confusion over the classification of current vehicle technologies. Because the SAE guide does not include a translation for all the different ADAS technologies, Consumer Reports has developed an expanded taxonomy to incorporate the various ADAS technologies into the different SAE automation levels (see chart on page 12):

Automation has enormous potential to make our roads safer by significantly reducing crashes attributable to driver error, and to improve mobility for millions of older Americans, individuals with disabilities, and other consumers nationwide. CR supports expanded development of this technology and its use where it is demonstrated to be safe. Accelerating this promising innovation should be guided by active efforts toward accountability, including sensible, enforceable, evidence-based measures to protect consumers against new hazards that may emerge, and data and information sharing to ensure consumers understand the benefits, risks, and limitations of the various system applications.

Safety or Convenience

As currently implemented, although advanced driver assistance systems provide "assistance," not all are necessarily safety features. This is an important distinction: Some are convenience features instead. Safety features help the driver see better, warn the driver of a potential crash/hazardous situation, or temporarily intervene to take over some driving functions to avoid or mitigate a crash. Convenience features, with the consent of the driver, take over some—or even all—driving functions to ease the driver's burden. But when a convenience feature has the potential to instill the driver with a false sense of security that could lead to inattention, it could actually cause serious harm.

A 2016 fatal crash involving a Tesla is an example of this problem and has been investigated in detail by the National Transportation Safety Board (NTSB). The NTSB found that the vehicle allowed the owner to over-rely on the automated system and to turn his attention away from the road, even though he was on a road outside of Tesla's Autopilot safe operating conditions. In this case, the driver had his hands on the wheel for only 25 seconds out of a period of 37 minutes. But given that a vehicle traveling at 60 mph will travel the length of a football field in just 3 seconds, even more moderate levels of inattention can be deadly.



State of Advanced Driver Assistance Systems (continued)

Based on testing, customer feedback, and review of existing crash data statistics, Consumer Reports classifies ADAS as follows:

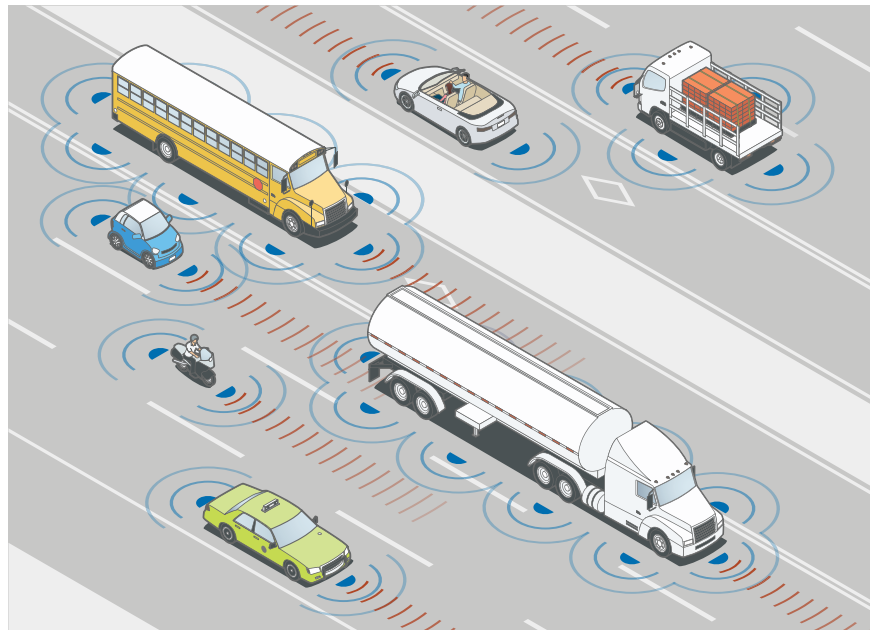
Consumer Reports Guide to Current Advanced Driving Assist Systems

	Visual Aids and Warnings	Emergency Driving Interventions	Partial Automation*
Responsible to Monitor Driving Environment	Human driver	Human driver	Human driver
Execution of Speed Control and Steering	Human driver	Human driver	System or System and human
Design Philosophy	Driver is in control	System backs up the driver	Driver backs up the system
Engaged only when needed for safety?	Yes	Yes	No (Engaged at driver's discretion when circumstances allow.)
Primary Benefit	Safety	Safety	Convenience
Automation Level	Level 0 (no Automation)	Level 0 (no Automation)	Level 1: Speed <u>OR</u> Steering Level 2: Speed <u>AND</u> Steering
Associated Features and Suggested Nomenclature (more details in Appendix)	Backup Camera BSW - Blind-Spot Warning Driver Monitoring System FCW - Forward-Collision Warning LDW - Lane-Departure Warning RCTW - Rear Cross-Traffic Warning	AEB - Automatic Emergency Braking LKA - Lane-Keeping Assist	ACC - Adaptive Cruise Control LCA - Lane-Centering Assist Both systems working together: (e.g., Autopilot, Drive Pilot, Pilot Assist, etc.)

*SAE gives Level 1 systems the name "Driver Assistance" and Level 2 systems the name "Partial Automation," but because all ADAS systems by definition are "Driver Assistance," CR is grouping both Level 1 and Level 2 systems as different kinds of "Partial Automation."

State of Advanced Driver Assistance Systems (continued)

Some may argue that adaptive cruise control (ACC) and lane-centering assist (LCA) can make driving safer by taking stress off the driver. Additionally, ACC can prevent tailgating and LCA can help the driver stay in the center of the lane. But research has yet to confirm those benefits, and they may be offset by partially disengaging the driver from the driving experience. As driver tasks are removed, a driver is more likely to lose situational awareness and could be more easily distracted. Even the advent of the automatic transmission removed some immediate engagement with the driving experience because drivers no longer need to monitor engine speed as the vehicle speed changes.



As driver tasks are removed, a driver is more likely to lose situational awareness and could be more easily distracted.

One remedy for this risk of inattention could be effective implementation of driver monitoring combined with a safe fallback system. More research is needed, but an effective driver monitoring system that can tell whether the driver is paying attention to road conditions—and therefore more ready to take full control if necessary—could ensure that these convenience features are safe.

State of Advanced Driver Assistance Systems (continued)

What's In a (Confusing) Name?

While the advanced driver assistance systems have great potential, their capabilities and functions can be confusing to consumers. Part of that stems from the lack of a common nomenclature. The wide range of names used poses a significant obstacle for widespread acceptance and effective use.

For example, there are more than a dozen names for automatic emergency braking (AEB). Basically, every automaker is going freestyle. The same too-many-names situation holds for other ADAS technologies, including forward-collision warning, which has been characterized and titled at least 10 different ways.

Too Many Nicknames Invite Consumer Confusion

<ul style="list-style-type: none"> Blind Spot Warning Active blind spot assist Side assist BLIS Blind spot detection Blind spot information Blind spot monitor Blind spot monitoring Lane change assist Rear vehicle monitoring 	<ul style="list-style-type: none"> Frontal collision warning City safety EyeSight Forward-collision alert Forward obstruction warning Front assist Active safe Pre sense Pre-collision assist Safety Sense 	<ul style="list-style-type: none"> Automatic emergency braking Active braking Active safe Autonomous emergency braking Collision mitigation Forward-collision mitigation system Forward emergency braking Front automatic braking Full auto brake Intelligent brake assist Pre sense front Pre-collision assist Pre-collision braking Pre-collision system Smart brake support 	<ul style="list-style-type: none"> Lane keeping assist Active lane assist Active lane keeping assist Lane assist Lane change assistant Lane departure prevention Lane keep assist Lane keeping aid Lane keeping system LaneSense Steering assist 	<ul style="list-style-type: none"> Rear Cross Traffic Warning Cross traffic alert Moving object detection Rear cross path detection Rear cross traffic alert Rear cross traffic assist Rear cross traffic monitor Rear traffic alert



State of Advanced Driver Assistance Systems (continued)

This is not a frivolous issue of semantics. Clear terminology is critical to a consumer's ability to make an informed purchasing decision, both when shopping across brands and when finalizing a purchase. We have heard accounts from consumers who purchased vehicles that they thought had specific advanced driver assistance capabilities only to figure out later that they did not. Consider how dangerous this can be.

Clear terminology is also critical to the safe use of advanced driver assistance systems. If a driver does not have a clear understanding of the function and purpose of a certain technology, he or she could wind up over-relying on it, turning it off, or overriding it in a critical situation.

For the purpose of this report, we will use CR's suggested nomenclature (see Appendix for glossary of terms) for the current systems on the market. Consumer Reports will be leading an effort to develop a consistent nomenclature that can be adopted and implemented as soon as possible to help consumers fully understand what they are purchasing.

Clear terminology is critical to a consumer's ability to make an informed purchasing decision, both when shopping across brands and when finalizing a purchase.

Clear Operating Capabilities and Limitations

Clear, consistent communication of the capabilities and limitations of advanced driver assistance systems is also crucial to both consumer acceptance and safety. A potentially dangerous example of why this matters: Some automatic emergency braking systems can detect pedestrians or bicyclists, and others cannot. Another example: Some Level 1 and Level 2 systems don't function effectively in severe weather, on certain roadway types, under certain lighting conditions, or when a vehicle is crossing in front of them.

The Department of Transportation defines what a vehicle can detect and respond to as the vehicle's object and event detection and response (OEDR), and when and under what conditions it can safely operate as its operating design domain (ODD). Because it is difficult to fully capture this key information within straightforward naming conventions for vehicle systems, those systems' names should be supplemented with instructions to make the vehicle's particular strengths and limitations extremely clear to consumers.

State of Advanced Driver Assistance Systems (continued)

Consumer Reports will be leading an effort to develop a consistent nomenclature that can be adopted and implemented as soon as possible to help consumers fully understand what they are purchasing.

Why? Because it is never safe to operate an automated system outside of its engineered parameters, or ODD. There should be no ambiguity as to the purpose and the limitations of a system from the automaker or, especially, the consumers' perspective.

Consider, for example, Cadillac's Super Cruise. That system is designed for use only on limited access freeways and does not allow operation when on other roads. If a driver doesn't fully understand that, it's a safety problem.

Because understanding capabilities and limitations of systems is so important, the best approach for the operating design domain is for the vehicle itself to be able to clearly and accurately alert and inform its driver whether the advanced assist system is inside or outside of its engineered abilities, or ODD. Further, the vehicle should not allow system operation outside of its ODD.



Considerations for Improving Consumer Acceptance

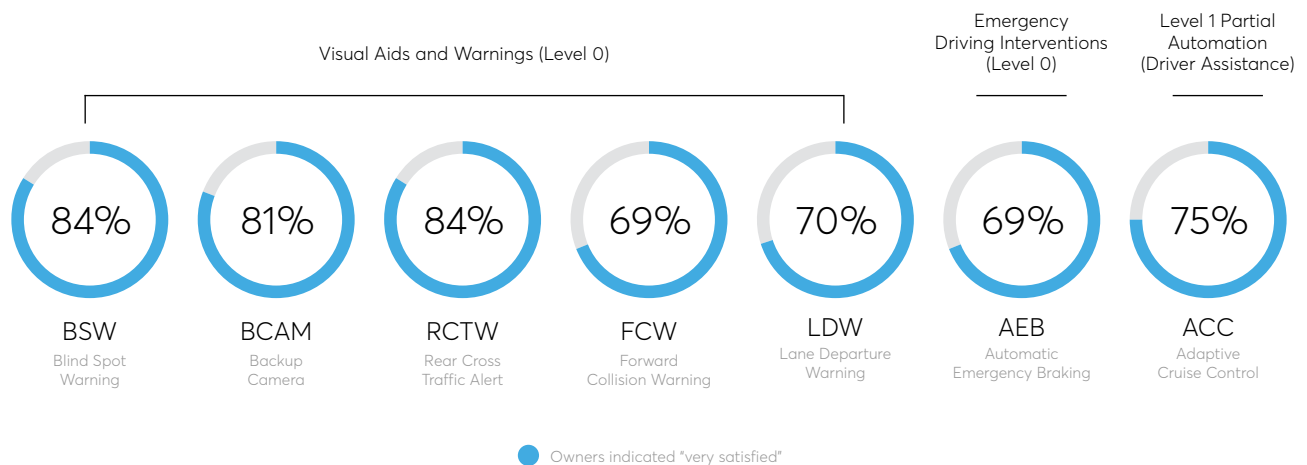
To further evaluate consumers' acceptance of the emerging ADAS systems, Consumer Reports surveyed more than 57,000 subscribers on satisfaction and experience of almost 66,000 vehicles they own that had ADAS systems in the fall of 2016. These consumer insights, combined with CR's expertise and extensive road tests, shape the following analysis. Note that Consumer Reports is making the data file available for interested parties upon request.

Satisfaction with Safety Systems

Most owners tell us they are very satisfied with their advanced driver assistance systems. This is in stark contrast to significantly lower satisfaction ratings for other newly added technologies, such as new infotainment systems and voice commands. Our research shows that ADAS systems that are easy to understand and don't require drivers to change the way they drive tend to be more satisfying.

Satisfaction with most visual aids is significantly higher than with systems that attempt to control the vehicle. Drivers appreciate visual information, especially if it provides clear feedback in intuitive locations. Another added benefit of visual aids is that they are generally easy to understand and require no training.

Comparison of ADAS System Satisfaction Among Vehicle Owners



Compared with systems that rely on visual aids, the driving intervention features—which include lane-departure warning and automatic emergency braking—appear to be somewhat less favored by consumers. But this result may be related more to a lack of familiarity with the particular feature. For example, automatic emergency braking, in particular, is an advanced driver assistance system that 13 percent of respondents say they haven't had any experience with, which impacts the satisfaction rates.

BLIND-SPOT WARNING



Brand	% Very Satisfied
Lincoln	88%
Lexus	88%
Hyundai	88%
Chrysler	87%
Toyota	87%
Cadillac	87%
Mercedes-Benz	87%
Buick	85%
Kia	85%
Subaru	85%
Mazda	85%
Jeep	85%
Acura	85%
GMC	84%
Volvo	84%
Dodge	84%
Audi	82%
Ford	82%
Chevrolet	82%
Jaguar	81%
Infiniti	79%
BMW	79%
Volkswagen	78%
Porsche	76%
Nissan	76%
Honda	70%
Tesla	62%

Blind-spot warning systems yielded very high marks from customers who had experience with the systems. Older drivers particularly appreciated the technology. Still, some implementations are more appreciated than others. The prominence, size, and placement of the alert is important. Many complaints were over signals that were too small or, worse, became washed out in direct sunlight. Others disliked lights that were not directly on the sideview mirror glass. Tesla owners were significantly less satisfied than any other auto brand, most likely due to the placement of the notification system in the gauges instead of the sideview mirrors—a location drivers told us is much more natural for them to look.

Preference for audible alerts depended on the particular driver. Most found the noise annoying. There seems to be an overall preference for alerts to be communicated only to the driver. It's possible that drivers do not want passengers to hear the vehicle "judging" their driving, or indicating they are doing a subpar job at the wheel. However, some drivers reported the opposite, saying a visual warning alone wasn't sufficient. It might be logical for manufacturers to allow users the option of using an audible warning, or not. Because most did not like the audible type of warning, it may make sense to turn it off upon delivery of a vehicle as long as another type of warning is on by default.

Many drivers simply assume that with this assistance system, they are no longer required to turn their head to check for blind spots. As the technology advances, maybe that assumption will prove true, but right now we strongly advise drivers to continue to check for blind spots.

Experiencing false warnings or, worse still, not being alerted of a nearby vehicle can undermine faith in a system. According to our research, owners of Volvo, Nissan, Mazda, and Infiniti vehicles reported the largest percentage of false alerts. Because we did not differentiate the age of the system, Volvo's false alerts results may be skewed by a relatively large amount of older systems in CR's survey.

Considerations for Improvement

There is an overall preference for alerts to be communicated only to the driver. The prominence, size, and placement of the alert is important. There appears to be a preference for the alert on the mirror glass area, where it is natural for the driver to look prior to a lane-change.



WHAT CONSUMERS ARE SAYING ABOUT BLIND-SPOT WARNING SYSTEMS

POSITIVE

“Would not buy a car without this feature.”
– 2015 Cadillac SRX owner

“I used to miss cars in my blind spot all the time. I wouldn't be without it. Think it should be standard on every car.”
– 2015 Hyundai Elantra owner

“Always works and is totally unobtrusive.”
– 2014 Lincoln MKX owner

“I absolutely love this feature. It keeps me from changing lanes and hitting someone and it is a big help in merging into a highway.”
– 2014 Lexus ES owner

“Very easy to understand/use”
– 2015 Mercedes-Benz C-Class owner

“Such a great feature, never had one before, don't want to be without one ever again.”
– 2015 Subaru Legacy owner

NEGATIVE

“Most cars we test-drove before purchasing the BMW had the blind spot monitor in the side view mirrors, which was easy to see. BMW has the monitor set outside of the mirror on the part that attaches to the car, which is out of eyesight when glancing.”
– 2016 BMW X5 owner

“I usually turn it off. It is an annoyance to hear the loud noise when I don't feel I need the warning.”
– 2015 Chevrolet Traverse owner

“In a traffic situation, such as heavy traffic (traffic jams) it is on constantly and is annoying.”
– 2015 Mazda CX-5 owner

“It must be 100% reliable or it's useless!”
– 2016 Buick Encore owner

“I do not like it—did not want it—need to figure out how to disable it.”
– 2016 Honda Odyssey owner

“Have to look at dashboard to see it function. Annoying.”
– 2015 Tesla Model S owner

“Easily turned off accidentally.”
– 2014 Toyota Sienna owner



BACKUP CAMERAS



Brand	% Very Satisfied
Tesla	94%
Lincoln	92%
Ram	91%
Cadillac	90%
Mazda	87%
Dodge	86%
Hyundai	86%
Jeep	86%
Lexus	86%
Volvo	86%
Audi	85%
BMW	85%
Buick	85%
Ford	85%
Mercedes-Benz	85%
Land Rover	84%
Infiniti	83%
Acura	82%
GMC	82%
Honda	82%
Kia	82%
Porsche	82%
Chrysler	81%
Jaguar	81%
Nissan	80%
Chevrolet	79%
Subaru	77%
Toyota	75%
Volkswagen	75%

Backup cameras from all makes scored high satisfaction reviews from consumers. Even among the lower-rated brands, people were still very satisfied. The highest-rated makes often provide very large, clear screens. The leading negative comment was that the display was too small. Other comments often pertained to picture quality, distortion, or obscured vision due to weather. Mounting the camera where it can stay dry, or even installing a self-cleaning function, could improve satisfaction. Cameras should engage promptly once the car is shifted into Reverse, without any other driver intervention.

Various manufacturers have added other visual parking features, such as 360-degree overhead views and front cameras, and Tesla has implemented a sensor that displays inches of room remaining. In general, these features work well and are appreciated.

Though rear cameras were designed as a safety feature to allow drivers to see what is in their blind spot, it seems like many survey respondents use backup cameras as more of a convenience feature. Not having to turn your head and being able to judge parking maneuvers were reported as the primary advantages by vehicle owners. Because today's backup cameras are not designed to replace mirrors or direct driver observation, we still strongly advise drivers to check their blind spots and scan rear and side mirrors when backing up.

Considerations for Improvement

Consumers prefer very large, clear screens and 360-degree functionality. Guidelines are also welcomed features. Cameras need to automatically turn on without hesitation. Additional opportunities include mounting the camera where it can stay dry and installing a self-cleaning function.

WHAT CONSUMERS ARE SAYING ABOUT BACKUP CAMERAS

POSITIVE

“Excellent large screen and clear view with turning guide lines when backing up.”

– 2014 Cadillac Escalade owner

“Colored safety lines on camera really help when backing into a parking spot.”

– 2014 Dodge Grand Caravan owner

“I’m older and head movement and vision are not as good as they use to be. Good views, safety issue, and I feel more confident backing up.”

– 2015 Honda CR-V owner

“It has red, green & yellow lines to indicate safety or danger. This has been extremely helpful.”

– 2015 Hyundai Elantra owner

“Provides a very sharp image and good visibility at night.”

– 2015 Lincoln MKC owner

“My first car with this feature. Love it.”

– 2016 Mazda 6 owner

“It sure helps when hooking up a trailer. The improved visibility makes it much safer when backing up.”

– 2015 Ram 1500 owner

“Amazing clarity and resolution.”

– 2015 Tesla Model S owner

“Great for low visibility, night, rain ...”

– 2015 Volvo XC70 owner

NEGATIVE

“It is so tiny that it can’t really be seen from the driver’s seat—or any other seat!”

– 2014 Subaru Forester owner

“Very small screen. Not very useful. Considerably smaller screen than is installed in less costly Toyota models such as the 2014 Corolla.”

– 2014 Toyota Sienna owner

“Bad picture, blurry.”

– 2016 Volkswagen Tiguan owner

“Very very slow to come up and be ready. Most times I have backed up and started forward before the camera comes on.”

– 2014 Volvo XC60 owner



REAR CROSS TRAFFIC WARNING



Brand	% Very Satisfied
Hyundai	90%
Volkswagen	89%
Kia	89%
Subaru	89%
Cadillac	88%
Volvo	88%
Mazda	87%
Lexus	86%
Toyota	86%
Dodge	85%
Chrysler	85%
Jeep	84%
Lincoln	83%
Buick	83%
Infiniti	82%
GMC	81%
Acura	81%
Chevrolet	81%
Ford	80%
Porsche	78%
Nissan	78%
Ram	76%
Tesla	75%
Audi	75%
BMW	74%
Mercedes-Benz	74%
Honda	69%

Overall, rear cross-traffic warnings (RCTW) help solve an unintended problem created by backup camera technology. For those who rely on cameras while backing up, RCTW helps make up for the lack of peripheral vision. As with other systems that feature visual aids, RCTW were generally well-liked by users, but as noted in consumer comments, some frustration exists. Sometimes, consumers said these systems were confused or did not work in concert with other aids. The survey relied on users to self-report whether their vehicles had these systems.

Like with other driver assistance features, confidence in the system is important and can be undermined by false alerts or a lack of appropriate alerts. Backing out of garages, our survey found, seemed to trigger false alerts. Perhaps this glitch is something future systems can be programmed to detect and avoid.

Considerations for Improvement

Minimize false alerts (for example, backing out of a garage). Better execute situations when multiple warnings are needed simultaneously.



WHAT CONSUMERS ARE SAYING ABOUT REAR CROSS-TRAFFIC WARNING

POSITIVE

“It came in handy when a car sped by as I was backing out of a spot in a mall.”

– 2014 Cadillac ATS owner

“Wonderful to have when parked in a lot between two SUVs and a narrow traffic lane.”

– 2017 Hyundai Elantra owner

“It has warned of rear traffic that might otherwise have been missed.”

– 2016 Kia Sorento owner

“It is very dependable for both cars and pedestrians.”

– 2014 Lexus ES owner

“It’s a great feature; every car should have it.”

– 2014 Mazda3 owner

“Works great when backing out in high traffic, would not have another car without it.”

– 2015 Subaru Outback owner

NEGATIVE

“The sensors go off when there is no one there.”

– 2015 Audi Q5 owner

“Frequently goes off in reverse due to having a hitch installed.”

– 2015 Chevrolet Silverado 2500HD owner

“Constantly beeps while backing out of the garage or parking spaces.”

– 2014 Chevrolet Volt owner

“In reverse, backing out of a parking space, the front proximity warning screams an audible alarm that masks the more useful side and rear proximity alarms, with the result that the alarms are largely useless and quite annoying.”

– 2015 Jaguar XJ owner



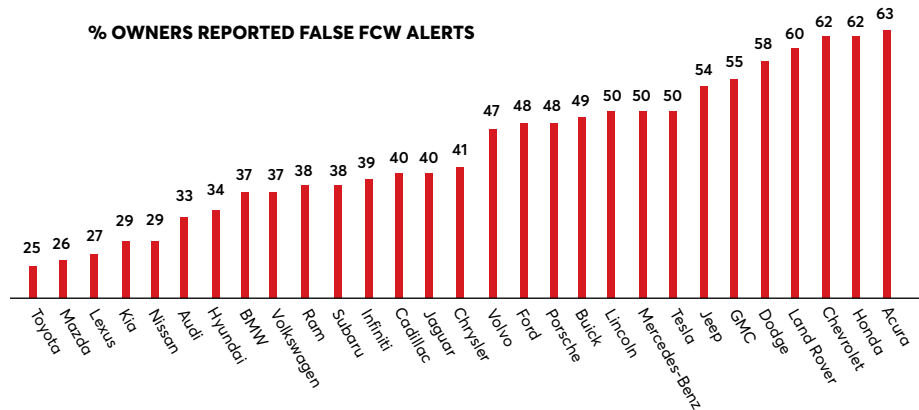
FORWARD-COLLISION WARNING



Brand	% Very Satisfied
Tesla	82%
Infiniti	82%
Subaru	80%
Lincoln	79%
Chrysler	78%
Cadillac	75%
Nissan	73%
Lexus	73%
Hyundai	73%
Kia	72%
Volvo	70%
Ford	70%
Audi	69%
Toyota	68%
GMC	68%
Jeep	68%
Volkswagen	67%
Dodge	67%
Buick	65%
BMW	64%
Mercedes-Benz	61%
Chevrolet	61%
Mazda	58%
Honda	58%
Acura	52%

Satisfaction with forward-collision warning systems depended on how well they performed in a particular vehicle. Overall satisfaction was high, especially for vehicle systems that did not generate a high number of repeated false alerts. Drivers who experienced frequent unnecessary alerts expressed extreme frustration with the feature. Though 45 percent of the respondents reported that they experienced at least one false alert, there was a wide discrepancy of false alert reports between makes. Only 25 percent of Toyota owners, but more than 60 percent of Honda, Acura, and Chevrolet owners, reported getting at least one false alert. False alerts are not helpful to drivers and may present potentially dangerous distractions.

% OWNERS REPORTED FALSE FCW ALERTS



Mazda owners did not report getting many false alerts from their vehicles' forward-collision warning system, and yet their satisfaction with it was still low overall. This could be because some Mazdas only provide alerts once the automatic emergency braking, or AEB, is in operation, and that is too late for the driver to react unassisted to a legitimate alert. In addition, many Mazda advanced driver assistance installations operate only while driving at low speed. Mazda owners with forward-collision warning were four times as likely to never experience an alert of any kind compared with owners of the same system from other automakers.

Consumer feedback from other brands, such as BMW, expressed displeasure with the design limitations of the system. Consumers told us that they expected the vehicle to apply the brakes when it sensed an imminent collision and were surprised when it did not. BMW continues to charge extra for its automatic emergency braking features.



Drivers with forward-collision systems also reported frustration when an alert sounded during ordinary road situations that ultimately required no reaction or input from the driver. Examples included alarms going off when approaching a vehicle that was turning or when closing in on a slower car prior to passing it. Some vehicles provide adjustable sensitivity settings that can help lessen alerts in these types of situations, but the settings can be difficult to find.

The nature of the alert is another variable. In general, the audible and visual alerts are adequate for getting the attention of the driver. Displays at or near eye level are advantageous because they encourage the driver to keep focused on the road. Displays in the gauge cluster can be effective with large, clear text. However, unclear text in the gauge cluster at the precise moment that the driver should be looking at the road can add confusion and distraction.

Considerations for Improvement

False alerts, when they occur, are frustrating and distracting to the consumer. The nature and clarity of the alert (audible or visual) and the sensitivity can be problematic.

Any visual alert should direct the driver's vision to the road. Some manufacturers could improve performance and consumer satisfaction by combining forward-collision warning and automatic emergency braking as a seamless package, and ensuring that FCW alerts occur before AEB is required to activate.



WHAT CONSUMERS ARE SAYING ABOUT FORWARD-COLLISION WARNING

POSITIVE

“Heads-up display flashes immediately in line of vision so that you don't miss it.”

– 2016 Cadillac CT6 owner

“It makes you feel like you have a second set of eyes on the road.”

– 2015 Chrysler 200 owner

“Has been a life saver.”

– 2015 Infiniti Q70 owner

“It is reliable and has saved me running into the car ahead of me.”

– 2016 Lexus NX owner

“Has been very reliable and saved a couple of accidents.”

– 2016 Lincoln MKX owner

“I like the scaled warning system, alerts followed by braking.”

– 2015 Nissan Murano owner

“It's reliable and gives peace of mind knowing it's there.”

– 2015 Subaru Legacy owner

“Works great. Has saved my bacon at least twice.”

– 2016 Tesla Model S owner

NEGATIVE

“It frequently sounds when there's nothing in front of the car to hit, just a slight topography change, like a slight incline. It also has, but hasn't always, sounded when a car in front of it has suddenly braked.”

– 2014 Acura MDX owner

“The audible alarm is same as others and it requires you to look down to see what the warning is (“BRAKE” or lane departure), potentially creating another distraction hazard.”

– 2014 Acura MDX owner

“I hate this feature and would not recommend it. I was led to believe that the car would automatically brake if the car was close enough to have a collision. Instead, a red light flashed very quickly and then goes off.”

– 2016 BMW X5 owner

“False alerts potentially due to sun glare/shadows. Also false alerts for no apparent reason.”

– 2015 Chevrolet Suburban owner

“This is not good. It triggers in sun glare and it scares the bejesus out of me every time. I'm so glad I don't have the automatic braking on because it would cause an accident. It triggers on the interstate. It's really awful.”

– 2015 Cadillac SRX owner

“The thing beeps when passing car stopped in the other lane or at trees, street signs, or poles.”

– 2015 Mercedes-Benz E-Class owner

“I can count on my hand the number of times the system has accurately identified an emergency situation. But the number of random dings we get when just driving down the road is maddening.”

– 2015 Mercedes-Benz M-Class owner

AUTOMATIC EMERGENCY BRAKING



Brand	% Very Satisfied
Lincoln	78%
Tesla	76%
Infiniti	75%
Chrysler	75%
Subaru	75%
GMC	74%
Nissan	73%
Ford	73%
Cadillac	72%
Audi	71%
Hyundai	71%
Mercedes-Benz	70%
Buick	69%
Kia	69%
Volkswagen	69%
Lexus	66%
Volvo	66%
Toyota	65%
BMW	63%
Jeep	63%
Dodge	63%
Honda	62%
Chevrolet	62%
Acura	61%
Mazda	52%

According to data analyzed by the Insurance Institute for Highway Safety, automatic emergency braking has demonstrated itself as very effective at preventing crashes. Our data show that 79 percent of drivers never experienced a false activation of AEB. However, false activations do occasionally occur, and they can be frightening. Among reports of false alerts, some can be explained away by a driver's lack of understanding of what AEB is supposed to be. Some consumers reported a false FCW alert as, instead, a failure of the AEB system, among others. Meanwhile, other drivers experienced unwelcome AEB activations that misinterpreted their own actions and intentions on the road.

Overall, consumer sentiments ran much more positive than negative when it came to automatic emergency braking. Many drivers felt that the system prevented crashes and saved their lives. But it's likely that the true advantage of automatic emergency braking comes into play most often when a driver is not actively paying attention and needs system intervention. Reports of unwelcome activations of automatic braking occur most often when a driver is paying attention and in control and doesn't want to be overridden.

Considerations for Improvement

Though rare, the incidence of false activations needs to be reduced further because those activations could trigger a crash, and also because too many false alerts may result in consumer mistrust for a safety system that has already been shown to prevent crashes. Consumers need to be clearly trained in how the system works and when it engages.

WHAT CONSUMERS ARE SAYING ABOUT AUTOMATIC EMERGENCY BRAKING

POSITIVE

“The collision warning and automatic braking saved us from running into the rear of another car when the traffic came to an abrupt stop from 60 mph just as I was distracted.”

– 2015 Chrysler 200 owner

“I really like it, I had someone dart out in front of me from a stop in another traffic lane. I saw it about to happen and went for the brakes and the system stopped the car before I got my foot on the pedal.”

– 2015 Ford Explorer owner

“It stopped my Acadia in the middle lane of traffic when a car made a dead stop in front of me with no accident.”

– 2014 GMC Acadia owner

“It is much faster than me reacting to emergency situations. The brakes are already applied before my foot hits the pedal and I take control.”

– 2014 Infiniti Q50 owner

“A driver passed me and cut in front of me and jammed on his brakes to make a right hand turn. The car automatically stopped me before I could react.”

– 2016 Lincoln MKX owner

“Worked perfectly in an emergency.”

– 2015 Nissan Murano owner

“My new driver said she had an emergency stop and by the time her foot got to the brake pedal the car was already stopping. She feels it prevented an accident.”

– 2015 Subaru Legacy owner

NEGATIVE

“Slamming on the brakes because a car in front is turning right is dangerous and will cause unnecessary rear end collisions.”

– 2016 Acura RLX owner

“When a car is turning, sometimes it thinks I won't stop in time...I know it's turning out of the way but computer doesn't ...”

– 2014 Jeep Cherokee owner

“I had it brake once when I didn't want it to and almost caused me to be rear-ended. I had the braking under control but I guess it thought better, but that almost caused an accident where none was going to happen. I would hate to disable it though.”

– 2016 Toyota RAV4 owner



LANE DEPARTURE WARNING



Brand	% Very Satisfied
Hyundai	80%
Chrysler	80%
Cadillac	80%
Tesla	78%
Dodge	78%
Jeep	76%
Lexus	76%
BMW	75%
Lincoln	74%
Volvo	73%
Mazda	73%
Buick	72%
Toyota	72%
Mercedes-Benz	72%
Ford	72%
Chevrolet	72%
GMC	71%
Kia	71%
Subaru	69%
Infiniti	67%
Acura	66%
Nissan	65%
Audi	65%
Honda	58%

Technologies that help prevent a vehicle from leaving the roadway have great potential to prevent crashes, injuries, and deaths, and some recent studies of existing lane-departure warning systems have found them to be effective.

But based on our research, survey, and testing, lane-departure warning systems still generally fail at differentiating between those times a driver truly needs assistance and circumstances when they don't. And as a result, they tend to frustrate consumers.

While overall satisfaction with lane-departure warning is relatively high, there were many complaints of unnecessary warnings. This annoyance factor can cause drivers to shut off their car's lane-assist system, rendering it useless at times it is needed the most. An emerging automaker trend is to make lane-departure warning easier to shut off by putting the disable switch right on the steering wheel.

Lane-departure warnings could potentially be far more effective if they did a better job of distinguishing dangerous situations from commonplace and intuitive driving habits and adjustments.

There are myriad reasons why a driver may intentionally cross lane lines without the need for a safety alert. The most common complaint of lane-departure warnings involves false alerts on curvy, narrow roads. In these situations, the driver is alert and in control but chooses to cross lane markings depending on road conditions and traffic. The driver may choose to increase the radius of a sharp corner when visibility is sufficient to see that no traffic is approaching.

If the system was able to determine when the driver was actively steering and limit activation in such instances, it could improve consumer confidence in its assistance and help convince drivers not to disable the feature. If a system could take other factors into account, such as a driver's steering rate, GPS-based road classifications, or a higher speed threshold, it might reduce the number of unnecessary warnings.

Drivers can also be annoyed by warnings when they hug or favor one side of the lane to avoid another vehicle or a soft shoulder, or give way to an obstacle. The center of the lane is not always the safest path. The systems need to improve their ability to determine whether the driver is actively steering in these situations.

Computer vision that can sense an obstacle that is being avoided might be useful. Driver monitoring (either via camera or through driving-performance measures) could also be useful to verify the intention of the driver in real time.

More research is needed to determine the best way to convey a warning message. A beep or a vibrating seat that is not supplemented with visual information alerts can be confusing. A vibration in the steering wheel may be more easily recognized by the driver, especially if it simulates the sensation of roadway rumble strips. As with other warnings, those that inform only the driver but not the passengers seem to be preferred. (Seems nobody likes to be publicly reprimanded.) Displays should also allow drivers to keep their eyes on the road.

Considerations for Improvement

Minimize unnecessary warnings and improve the systems' ability to distinguish actual danger by better leveraging inputs, such as steering rate, GPS-based road classifications, or even an elevated speed threshold. And more research is needed to determine the best possible ways to communicate warning messaging to drivers.



WHAT CONSUMERS ARE SAYING ABOUT LANE-DEPARTURE WARNING

POSITIVE

“Requires you to pay attention to your driving, reduces distractions.”

– 2014 Buick Lacrosse owner

“Good reminder when getting close to leaving your lane and reminds you when you forget to signal a lane change.”

– 2015 Cadillac Escalade owner

“Vibrating seat warns me without annoying or alarming my passengers.”

– 2014 Cadillac XTS owner

“It could save lives. I would not want a car that is not equipped with this feature.”

– 2016 Lexus NX owner

“It could save lives. I would not want a car that is not equipped with this feature.”

– 2015 Chrysler 300 owner

“It just works. Wonderful for long interstate trips.”

– 2015 Hyundai Sonata owner

“Just like driving on rumble strips and better than my Mercedes where steering wheel vibrated, passengers can also hear it, which I think makes it safer if driver unaware.”

– 2015 Tesla Model S owner

“It trained me to always use the signals when changing lanes.”

– 2015 Volvo S60 owner

NEGATIVE

“On narrow roads and curvy roads, you do not have lots of room to stay between the lines like the system wants you to. Most times I know what I am doing and this is a distraction. Probably just need to activate it for long trips only.”

– 2016 Honda Pilot owner

“It can be a little annoying when you are having to hug the right side line because of oncoming traffic being too close to the center line.”

– 2016 Subaru Outback owner

“When my car beeps, it's very hard to tell what it is beeping about. So I can't tell when a lane departure warning happens.”

– 2015 Mercedes-Benz C-Class owner



LANE-KEEPING ASSIST AND LANE-CENTERING ASSIST

(There's not enough survey data to rate brands, but consumer verbatims are provided.)



Active lane-departure aids have many of the same issues as lane-departure warnings (LDW) but vary in their abilities and appear to be less understood by drivers. Lane-keeping assist (LKA) is essentially an LDW that can react somewhat for the driver. Lane-centering assist (LCA) can actively steer the vehicle in its lane, eliminating the lateral feedback loop of driving. Both systems are implemented in varied ways, depending on the manufacturer.

These systems should be assisting the drivers, but in some cases drivers may feel that the vehicle is overriding them or even fighting them. As with LKA, these systems are better utilized on the highway, and they fail to recognize the areas where they should or should not be operating. If drivers shut off the systems before getting to areas where they are more appropriate, they will provide no benefit. Satisfaction with the systems would improve if they did a better job of determining when the driver is in control and when the driver truly requires assistance.

Considerations for Improvement

Systems need to better determine when the driver is in control and when the driver truly requires assistance.



WHAT CONSUMERS ARE SAYING ABOUT LANE-KEEPING ASSIST AND LANE-CENTERING ASSIST

POSITIVE

“Very helpful on long trips where one can get road hypnotized. It snaps you back into reality.”

– 2015 Ford Edge owner

“If it is on, steering is hard ... you’re fighting the automatic steering ... It’s easier to just let it do the steering, touching the wheel frequently enough so that the “Steering Required” message doesn’t flash.”

– 2016 Honda Pilot owner

“It’s a good safety feature when driving on the highway.”

– 2016 Subaru Outback owner

“This is part of autopilot. I have tried to learn when to use this and when not to. If you use it when appropriate it is great and provides a real safety benefit. If you try to use it in high-speed congestion, you’re crazy.”

– 2015 Tesla Model S owner

NEGATIVE

“I actually play with it, a la self-driving car, on quiet freeways. It’s fun to see it steer around curves. But otherwise it just induces an odd resistance in the steering and I don’t like arguing with my car over who’s in charge. I am, car-accept it.”

– 2015 Acura TLX owner

“When activated at full strength, the wheel is fairly hard to turn. I generally turn this system down and rely mainly on the warning system.”

– 2017 Audi Q7 owner

“I don’t like it grabbing the steering. It makes me feel like I don’t have control.”

– 2016 Chevrolet Tahoe owner

“Annoying when passing a bicycle on one lane road. I go over the center line to give a wide space and the system pushes me back in lane. To prevent this you have to put on the turn signal before crossing the line.”

– 2014 Mercedes-Benz E-Class owner



ADAPTIVE CRUISE CONTROL



Brand	% Very Satisfied
Tesla	92%
Volvo	83%
Lincoln	83%
Subaru	82%
Volkswagen	79%
Jeep	79%
Hyundai	77%
Dodge	77%
Cadillac	76%
Mercedes-Benz	76%
Chrysler	75%
Audi	74%
Kia	74%
Mazda	74%
Porsche	74%
Ford	74%
GMC	74%
Buick	73%
Infiniti	72%
Nissan	72%
Lexus	72%
Toyota	70%
Honda	70%
Chevrolet	67%
Acura	67%
BMW	66%

Though adaptive cruise control is very well-liked by drivers, Consumer Reports considers it a convenience feature, not a safety feature. However, it is often packaged with other safety-focused ADAS systems. Drivers appreciated the more capable systems that could operate in stop-and-go situations. Major complaints involved the jerkiness of acceleration and braking.

More effort should be made to make the systems operate smoothly. Other improvements could be made, such as recognizing brake lights of a lead vehicle. Because the systems don't automatically brake or lift off the throttle as a human would, they can lead to driver stress or a more severe reaction later. None of the systems that Consumer Reports has evaluated react to stop signs, even though many vehicles now have the ability to read them.

Considerations for Improvement

Some manufacturers have an opportunity to reduce jerkiness of acceleration and braking. A user setting to adjust the aggressiveness of acceleration and/or braking might be helpful. An evolution of this feature may be the ability to recognize brake lights, stop signs, or traffic lights.



WHAT CONSUMERS ARE SAYING ABOUT ADAPTIVE CRUISE CONTROL

POSITIVE

“I would not get another car without it. I can plant my two feet on the floor as if I was sitting in a normal chair. This prevents straining my back and cramping my right thigh. I only use it on long drives.”

– 2015 Hyundai Sonata owner

“Use it all the time. Prevents tail gating.”

– 2014 Jeep Grand Cherokee owner

“Really improves cruise control—easy to keep a safe distance with traffic.”

– 2015 Lincoln MKC owner

“It’s very convenient. Definitely makes driving in traffic on expressways more pleasant.”

– 2015 Subaru Impreza owner

“My favorite feature. I use it consistently during my commute (40 mi each way on surface and hwy).”

– 2016 Volvo S60 owner

NEGATIVE

“Unrefined, in fact scary at times. Rapid acceleration followed by hard braking, not smooth at all.”

– 2014 Acura MDX owner

“Works fine until a car passes and pulls in front, then an abrupt speed reduction.”

– 2015 BMW X3 owner

“Maybe it’s me, but it makes me nervous. Seems to come up on the car ahead and then brakes aggressively to maintain proper distance.”

– 2014 Ford Flex owner

“It is not smooth. It reacts late to slow and speed up. It slows down too much then tries to speed back up fast making a lot of engine noise. I have had this feature in other cars. This has been one of the more disappointing.”

– 2015 Infiniti QX60 owner

“Acceleration too hard when increasing speed.”

– 2015 Toyota Camry owner



CR'S INITIAL THOUGHTS ON LEVEL 2 AUTOMATION

Coupling today's adaptive cruise control and lane-centering assist technologies has led to the first Level 2 Partially Automated systems. There are currently several systems available, such as Cadillac's Super Cruise, Mercedes-Benz's Drive Pilot, Tesla's Autopilot, and Volvo's Pilot Assist.

There is little evidence to suggest whether these current Level 2 systems improve safety, and there are indications of the opposite effect, given that some drivers tend to push the limits of those systems and use them in situations for which they are not intended or designed. However, Cadillac's new Super Cruise system appears to help counter these driver tendencies for overreliance through the use of driver monitoring and limiting activation to only those situations in which the system was intended to operate.

Tesla owners tell us they love the system. Owners report that it makes driving less stressful and that they are able to drive long distances without fatigue. Such descriptions are consistent with a very effective convenience feature. It is possible that reduced fatigue could improve safety, as could a comfortable ride and quiet interior. But removing the driver's mental load could also lead to inattentiveness and distraction that might actually make driving less safe. At this point, we just don't have enough data or research to determine whether Level 2 systems are safer, less safe, or about the same as drivers using cars that lack these driver assistance features.

Based on our evaluation, Tesla's Autopilot is one of the most capable systems on the market, but it's worth noting that although Tesla's Autopilot is a Level 2 System, it can be misleading because its operation might feel more like a Level 3 than like other Level 2 implementations. Other manufacturers allow the driver to steer without disabling the system. Tesla's implementation actually discourages the driver from taking an active part in the driving experience, essentially allowing the vehicle to drive with its human driver serving as merely a backup to the automated system. Handing over control like this can lead to overreliance on the system.

Most systems monitor whether the driver has his or her hands on the wheel by monitoring resistive torque. However, this can create frustration and confusion if the vehicle is steering appropriately and doesn't require correction. For instance, Tesla vehicles automatically disable Autopilot when the driver applies torque to the wheel, but the system also alerts the driver to hold the wheel

WHAT CONSUMERS ARE SAYING ABOUT LEVEL 2 AUTOMATION

“It just works. I arrive refreshed when using autopilot on a grueling commute. Love autopilot and use it everyday!!”

– 2015 Tesla Model S owner

“It's getting better with every upgrade. It can still be quirky. The best application is for stop and go traffic. It dramatically reduces the stress associated with stop and go traffic. It can lull you to sleep on long drives on the Interstate.”

– 2015 Tesla Model S owner

“It makes driving less stressful. I hate it that idiots think it is autonomous and the press calls it “self driving.” It is a driver assistance feature, not self driving.”

– 2015 Tesla Model S owner



more fully when he doesn't apply enough torque while steering. According to our survey and testing, this can be quite annoying to drivers using the system.

Cadillac's approach with its Super Cruise helps clear up the ambiguity of who is in control. In its Level 2 system, the driver is not required to touch the steering wheel and applies torque to the wheel only when required to steer the vehicle. Lights on the steering-wheel rim help make it clear exactly who is in control at any given time, the system or the human driver. Only when a green bar is illuminated on the steering wheel is the vehicle actively steering and the driver doesn't need to touch the wheel.

Another control ambiguity challenge with current Level 2 systems on the market today is tied to naming conventions. More research is required to determine the degree to which names like Drive Pilot and Autopilot give consumers the impression that these systems can fully take over the functioning of the vehicle, consistent with Level 3 automation. Such research should explore whether names building on cruise control, such as Super Cruise, that more accurately describe the system can avoid such risks. Until research is completed, the precautionary approach should be to avoid names that include pilot for Level 2 systems.

The current ADAS systems utilize some of the building blocks that will lead to more capable self-driving vehicles in the future. But for these systems to be safe on roads now, the driver must fully understand his or her responsibility at all times, and the system's capabilities must not be oversold through advertising or how it is named. And as these systems reach their performance threshold, the transfer of steering or throttle control back to the driver must be completely clear and provide sufficient time for the driver to smoothly regain control of the vehicle.

Last, these systems bring up the issue of having a safe fallback mode that can return the vehicle to minimal risk conditions for all automated systems at Level 2 or above. A fallback approach is critical if either the automated system malfunctions or drivers are not taking over control of the vehicle when they should.

If a vehicle is moving from within its operating design domain to beyond what it is intended to do, then it is essentially malfunctioning and should immediately warn the driver to regain control. If the driver is unable or unwilling to take over, or if the vehicle has no driver controls, the vehicle should be engineered to transition back into conditions where it can operate with minimal risk. Ideally, this would mean that the system could safely pull the

Until research is completed, the precautionary approach should be to avoid names that include pilot for Level 2 systems.



If a vehicle is moving from within its operating design domain to beyond what it is intended to do, then it is essentially malfunctioning and should immediately warn the driver to regain control.

vehicle over either to the side of the road or to an even safer spot off the road.

If the system is unable to change lanes, such as for some Level 2 vehicles or malfunctioning Levels 3 to 5 vehicles, the vehicle should not simply keep driving. More research is needed to help determine what the safest fallback condition would be, but that reality should not be used as a reason to fail to include one now.

Further, as the Department of Transportation indicates, "Fallback strategies should take into account that, despite laws and regulations to the contrary, human drivers may be inattentive, under the influence of alcohol or other substances, drowsy, or otherwise impaired."

Considerations for Improvement

Though more research is needed to determine the safety of Level 2 systems and to improve their design, CR experience to date indicates that both the operation of the system and the name used should leave no ambiguity over who is in control of the vehicle at any time. Further, driver monitoring or other approaches to system design should ensure that it is clear that the role of the driver remains to monitor the driving environment. Last, all Level 2 vehicles should include a safe fallback mode and should neither continue driving nor simply turn off the system at speed if the system malfunctions or a driver remains inattentive despite warnings.



Consumer Reports Considerations for Future Ratings

When data supports the effectiveness of emerging safety systems, Consumer Reports believes in the widespread adoption of those technologies. Currently, forward-collision warning and automatic emergency braking have shown to be the most beneficial in preventing and mitigating crashes. Consumer Reports has responded by raising the Overall Score of any car that provides these systems as standard equipment across every trim of a model line, making them more accessible to a greater number of consumers.

Standard Safety Feature	Consumer Reports Scoring Criteria
FCW	One point added to Overall Vehicle Score
Low-Speed AEB	One point added to Overall Vehicle Score
Highway-Speed AEB	One point added to Overall Vehicle Score

As can be seen from the above chart, a vehicle model that provides both of those safety systems, which can operate up to highway speeds, as standard equipment can gain up to three additional points in the overall score. This can make a real difference in a model's overall rating. For example, when Nissan added these features as standard equipment on the 2018 Altima, Consumer Reports immediately increased the score and began to recommend the model.

CR will continue to review data and may make further changes to scoring criteria. Several manufacturers have implemented automatic emergency braking that functions only at speeds below 25 mph. Though these systems certainly can prevent crashes, fatalities and serious injuries are far more likely to occur at higher speeds. One option being considered is to remove any score for a low-speed-only AEB system and increase the points added for higher-speed systems. With data emerging on the effectiveness of lane-departure warning and blind-spot warning systems, CR is also considering revised scoring options for those safety features.

As automakers add automation systems, consumer expectations for vehicle safety and security will change and rise, and the repercussions of a failure to meet those expectations will grow. Therefore, with the finalization of the DOT automated vehicle guidance, CR will consider whether to include in our ratings some or all of the safety elements in the guidance, and other related considerations discussed in this report.



**When data supports the effectiveness
of emerging safety systems,
Consumer Reports believes in the
widespread adoption of those technologies.**

Consumer Reports will also consider whether to include in its scoring the submission of the safety self-assessment itself and the degree of transparency around a vehicle model's automation features. While the Safety Self-Assessments—as they are referred to in the updated DOT guidance—may currently be voluntary in the eyes of the government, automakers should consider them as mandatory to gaining consumers' trust and interest in the technology. Last, though not currently included in those assessments, the critical issues of privacy, ethics, data sharing, and registration and third-party certification of these internet-connected systems should be considered, evaluated, and publicly disclosed by automakers. Going forward, Consumer Reports will also consider adding categories for these key considerations in our scoring and rating criteria.



About Consumer Reports and Next Steps

Consumer Reports is an independent, nonprofit organization that works side by side with consumers to create a fairer, safer, and healthier world. For 80 years, CR has provided evidence-based product testing and ratings, rigorous research, hard-hitting investigative journalism, public education, and steadfast policy action on behalf of consumers' interests. Unconstrained by advertising or other commercial influences, CR has exposed landmark public health and safety issues and strives to be a catalyst for pro-consumer changes in the marketplace. From championing responsible auto-safety standards to winning food and water protections to enhancing healthcare quality to fighting back against predatory lenders in the financial markets, Consumer Reports has always been on the front lines, raising the voices of consumers.

To learn more about how Consumer Reports tests products, please go to **ConsumerReports.org/cro/about-us/whats-behind-the-ratings/index.htm**.

Please email **autosafety@consumer.org** if you're interested in any of the following:

- Receiving underlying consumer satisfaction of advanced driver systems data
- General feedback on the report
- Interest in participating in more clear and standardized naming conventions



Appendix

CR'S GLOSSARY OF TERMS AND ACRONYMS FOR LEVELS OF AUTONOMY

VISUAL AIDS AND WARNINGS (LEVEL 0)

Visual aids and warnings are not autonomous features and are classified as Level 0. These systems are designed only to enhance driver awareness, not to replace driver attentiveness.

Backup camera—Through a screen in the dashboard, provides a view of what is behind the vehicle while the vehicle is backing up, to avoid running over children and older adults.

Blind-spot warning (BSW)—Visual and/or audible notification of another vehicle in the driver's blind spot. The system may provide an additional warning if you use your turn signal when there is a car next to you in the adjoining lane. Sometimes called BLIS, BSM, etc.

Driver monitoring—Using cameras, infrared sensors, or other approaches to determine whether the driver is actively engaged in the driving tasks. Can include a warning or may disable driver intervention or automation systems.

Forward-collision warning (FCW)—Visual and/or audible warning intended to alert the driver to help prevent a collision.

Lane-departure warning (LDW)—Visual, audible, or haptic alert (e.g., steering-wheel shakes) warns the driver when the car crosses lane markings.

Rear cross-traffic warning (RCTW)—Visual, audible, or haptic notification (steering-wheel shakes, seat buzzes) of object or vehicle out of rear camera range but that could be moving into your path. Sometimes called rear cross-traffic monitoring (RCTM).

EMERGENCY DRIVING INTERVENTIONS (LEVEL 0)

Emergency driving intervention systems are not autonomous features and are also classified as Level 0. These systems are designed only to back up the driver in an emergency with a momentary intervention, and not to handle routine driving tasks. Data from the IIHS have proved that they can be effective in preventing and mitigating crashes.

Automatic emergency braking (AEB)—Brakes are automatically applied to prevent a collision or reduce collision impact force.



Lane-keeping assist (LKA)—Automatic corrective steering input or braking provided by the vehicle when the car crosses lane markings without the driver activating the turn signal.

LEVEL 1 PARTIAL AUTOMATION (DRIVER ASSISTANCE)

These driver assistance systems independently handle either steering or speed control and are classified as Level 1. These systems require the driver to continually monitor the system and be available to take over immediately if needed. The Society of Automotive Engineers (SAE) gives Level 1 systems the name “Driver Assistance” and Level 2 systems the name “Partial Automation,” but because all ADAS systems by definition are “Driver Assistance,” CR is grouping both Level 1 and Level 2 systems as different kinds of “Partial Automation.”

Lane-centering assist (LCA)—Continuous active steering to keep car between lanes. Sometimes called Active Steer, Autosteer, etc.

Adaptive cruise control (ACC)—Uses lasers, radar, cameras, or a combination of these to keep a constant, safe distance between you and the car ahead of you. If highway traffic slows, some systems will bring the car to a complete stop and automatically come back to speed when traffic gets going again, allowing the driver to do little more than pay attention and steer.

LEVEL 2 PARTIAL AUTOMATION

Partial automation systems combine two different driver assistance features operating cooperatively to take over the task of driving under limited circumstances and are classified as Level 2. Just like Level 1 Partial Automation, these systems require the driver to continually monitor the system and be available to take over immediately if needed.

Current Level 2 systems are a combination of LCA and ACC. Examples include Cadillac’s Super Cruise, Mercedes-Benz’s Drive Pilot, Tesla’s Autopilot, and Volvo’s Pilot Assist.

CONDITIONAL AUTOMATION (LEVEL 3)

Conditional automation systems add the ability to change lanes and fully navigate between two points under limited circumstances, such as on a divided highway. The human driver must take over when conditions change or the vehicle is otherwise outside the predetermined circumstances.

There are no Level 3 commercial products yet on the road, though some are in testing.



HIGH AUTOMATION (LEVEL 4)

Vehicles with high automation turn over full control to navigate between two points within a specific geographic boundary using geofencing or other limitations. The vehicle may have no traditional controls at all, and the human driver never needs to take over.

There are no Level 4 commercial products yet on the road, though some are in testing.

FULL AUTOMATION (LEVEL 5)

Full automation allows the vehicle full control under all circumstances in all locations. The vehicle will require no traditional controls at all, and the human driver never takes over.

There are no Level 5 commercial products yet on the road.

