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March 2024

DRIVER ASSISTANCE TECHNOLOGIES

NHTSA Should Take Action to Enhance Consumer Understanding of Capabilities and Limitations

Accessible Version

GAO-24-106255

GAO Highlights

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Highlights of GAO-24-106255, a report to congressional committees
March 2024

DRIVER ASSISTANCE TECHNOLOGIES

NHTSA Should Take Action to Enhance Consumer Understanding of Capabilities and Limitations

Why GAO Did This Study

According to NHTSA, almost 42,800 people died in vehicle crashes in 2022. New vehicles are increasingly equipped with driver assistance technologies that could help reduce crashes and fatalities. NHTSA administers NCAP to educate consumers about vehicle safety, including driver assistance technologies, and to assist in consumers' purchasing decisions.

The Consolidated Appropriations Act, 2022, included a provision for GAO to review consumer education about driver assistance technologies. Among the issues this report examines are (1) consumers' use and understanding of driver assistance technologies; and (2) the extent to which NHTSA contributes to consumers' understanding and using the technologies as intended.

GAO reviewed NHTSA's relevant rulemaking documents, website, and studies; analyzed a nongeneralizable sample of NHTSA consumer complaint data; and interviewed NHTSA and other relevant agency officials and a range of industry stakeholders, including automakers and safety organizations. GAO assessed NHTSA's efforts against key project schedule management practices.

What GAO Recommends

GAO is making five recommendations, including that NHTSA finalize its NCAP roadmap, communicate progress on meeting time frames to update NCAP, and provide information to consumers on the limitations of partial driving automation systems on its website.

NHTSA agreed with our recommendations.

What GAO Found

New vehicles are increasingly equipped with driver assistance technologies designed to prevent or mitigate crashes (crash avoidance technologies) and support the driving task (driver support systems). According to interviewed stakeholders and research GAO reviewed, when drivers have a realistic understanding of their vehicles' driver assistance technologies, they are more likely to use them as intended. There is some evidence, however, that consumers do not always have an accurate understanding of technologies'

capabilities and limitations. One study found that between 27 and 79 percent of consumers surveyed had misperceptions about the limitations of different crash avoidance technologies in their vehicles. In addition, misuse is a safety concern particular to partial driving automation systems, a type of driver support system, which can take over some of the driving tasks in a vehicle but still requires the full attention of the driver.

Vehicle Dashboard Displays Driver Assistance Technology Activation

Source: GAO (photo). | GAO-24-106255

Within the Department of Transportation, the National Highway Traffic Safety Administration (NHTSA) provides consumers with information on crash avoidance technologies through its New Car Assessment Program (NCAP), additional information on its website, and other means. NHTSA uses checkmarks to indicate whether vehicles come equipped with the four crash avoidance technologies that it recommends and that meet NHTSA's performance criteria. In 2022, NHTSA published a draft roadmap with plans to upgrade NCAP, including recommending four more crash avoidance technologies and developing a rating system for them. These upgrades would provide more comprehensive and comparative information to consumers. However, NHTSA has not finalized its roadmap and has missed time frames even though work on these upgrades started years ago. Developing realistic time frames and publicly communicating its progress could help NHTSA provide consumers with more meaningful information. Aside from NCAP, NHTSA provides consumers with a description on partial driving automation systems, but there is little information about their intended use and operational limitations. Providing this information could assist consumers in developing a more accurate understanding of these systems.

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Abbreviations

AAA	American Automobile Association
AAMVA	The American Association of Motor Vehicle Administrators
DOT	Department of Transportation
FTC	Federal Trade Commission
GPS	global positioning system
IIHS	Insurance Institute for Highway Safety
NCAP	New Car Assessment Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PMBOK® Guide	A Guide to the Project Management Body of Knowledge
PMI	Project Management Institute

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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March 28, 2024

The Honorable Brian Schatz
Chair
The Honorable Cindy Hyde-Smith
Ranking Member
Subcommittee on Transportation, Housing and Urban Development, and Related Agencies
Committee on Appropriations
United States Senate

The Honorable Tom Cole
Chairman
The Honorable Mike Quigley
Ranking Member
Subcommittee on Transportation, Housing and Urban Development, and Related Agencies
Committee on Appropriations
House of Representatives

The National Highway Traffic Safety Administration (NHTSA) within the Department of Transportation (DOT) estimated that almost 42,800 people in the U.S. died in motor vehicle crashes in 2022.[1] In addition, in 2021, about 2.5 million people were injured in vehicle crashes. According to DOT, the increased use of crash avoidance technologies in vehicles could help reduce some of these fatalities and injuries. These technologies are designed to respond to hazards or to the threat of an imminent collision by intervening directly in certain driving tasks—such as braking and steering—or by providing information, alerts, or other warnings to drivers.

In addition to crash avoidance technologies, there are other types of driver assistance technologies, known as driver support systems, which, for example, can continuously maintain a vehicle's speed, distance between vehicles, or position in a lane, but still require the full attention of the driver. When combined, some of these driver support systems can enable partial driving automation systems, in which the vehicle can

[1]U.S. Department of Transportation, National Highway Traffic Safety Administration, *Early Estimates of Motor Vehicle Traffic Fatalities and Fatality Rate by Sub-Categories in 2022*, DOT HS 813 448 (Washington, D.C.: April 2023).

continuously support acceleration, braking, and steering functions. Automakers typically market these systems as convenience features, and according to DOT, data on these systems' net safety impacts are not yet available.

Safety organizations have expressed concerns about consumers' use of different types of driver assistance technologies. For crash avoidance technologies, concerns have focused on consumers turning them off and nullifying the safety benefits. On the other hand, some stakeholders have raised concerns about consumers' overreliance on partial driving automation systems due to misperceptions about, or misuse of, the systems. Such overreliance can pose a danger on the road. For example, the National Transportation Safety Board (NTSB) has found that drivers' misuse of vehicles with partial driving automation systems played a role in three fatal crashes and issued recommendations to NHTSA and the automobile industry to address this problem.[2] Some advocates believe that with better information from automakers, retailers, and governments, consumers may use driver assistance technologies in the ways they are intended, which would improve safety.

NHTSA is the lead federal agency generally responsible for motor vehicle safety. Its mission statement identifies education as one of four ways in which NHTSA is to carry out its mission to save lives, prevent injuries, and reduce economic costs due to road traffic crashes. Therefore, the agency plays a key role in providing information to the public about driver assistance technologies. It also administers the New Car Assessment Program (NCAP) with the intended purpose to educate consumers about the comparative safety performance of vehicles to assist consumers in vehicle purchasing decisions. Part of the program includes recommending certain crash avoidance technologies. The Federal Trade Commission (FTC) plays a role in information provided to consumers about these technologies by conducting investigations and taking

[2]National Transportation Safety Board, *Highway Accident Report: Collision Between a Sport Utility Vehicle Operating With Partial Driving Automation and a Crash Attenuator, Mountain View, California, March 23, 2018,* NTSB/HAR-20/01 (Washington, D.C.: March 20, 2020); *Highway Accident Brief: Collision Between Car Operating with Partial Driving Automation and Truck-Tractor Semitrailer, Delray Beach, Florida, March 1, 2019,* NTSB/HAB-20/01 (Washington, D.C.: Jan. 22, 2020); and *Highway Accident Report: Collision Between a Car Operating With Automated Vehicle Control Systems and a Tractor-Semitrailer Truck Near Williston Florida, May 7, 2016,* NTSB/HAR-17/02 (Washington, D.C.: Sept. 12, 2017).

enforcement actions against deceptive acts or practices, which could include misleading information from automakers.[3]

The explanatory statement accompanying the Consolidated Appropriations Act, 2022 includes a provision for us to report on consumer education about driver assistance technologies.[4] This report (1) discusses consumers' understanding and use of driver assistance technologies; (2) describes how selected automakers and retailers educate consumers about driver assistance technologies; and (3) assesses the extent to which NHTSA contributes to, and could further enhance, consumers' intended use and understanding of these technologies.

Our review includes the driver assistance technologies that NHTSA currently recommends in NCAP: forward collision warning, automatic emergency braking (dynamic brake support and crash imminent braking), and lane departure warning. Our review also includes the four technologies NHTSA has proposed to include in NCAP: pedestrian automatic emergency braking, lane-keeping support, blind spot warning, and blind spot intervention. For consistency, we used the NCAP terminology for these technologies whenever possible, although other entities may use different terms. We also examined partial driving automation systems, which, at a minimum, combine adaptive cruise control and lane centering and provided the highest level of automation widely available in U.S. vehicles for sale at the time of our review.

To discuss consumers' use of these technologies and their understanding of the technologies' safety benefits and limitations, we conducted a literature search and identified 74 relevant research studies and policy reports. We also conducted a non-generalizable review of consumer complaints that NHTSA received from 2020 through May 2023 about driver assistance technologies. Out of more than 260,000 complaints received during this time frame, we found around 5,000 with key words

[3]The FTC was not the focus of our review.

[4]In response to this provision, we provided a briefing on preliminary results to appropriate congressional staff in March 2023. The provision directing us to complete this work included a question about how governments are educating consumers about these technologies. We reached out to three safety associations that work with state governments and several state governments about their roles in educating consumers. For purposes of this report, we focused on how automakers and NHTSA educate consumers about driver assistance technologies and describe the state role in the background.

related to driver assistance technologies and reviewed a non-generalizable selection of 230 of them, after removing complaints we determined to be out of scope.

Furthermore, we interviewed a non-generalizable selection of stakeholders, including seven automakers, researchers from three academic institutions, and 12 safety, consumer, and industry associations. One additional automaker provided written responses, and we were unable to coordinate schedules for interviews with two other selected automakers. In addition, we conducted site visits with stakeholders involved in testing and evaluating driver assistance technologies to better understand how the technologies operate. We also interviewed FTC officials to obtain an understanding of how FTC collects and analyzes consumer complaints and its role in enforcing truth in advertising laws.

To determine how selected automakers educate consumers about driver assistance technologies, we reviewed the websites and vehicle owner's manuals of our 10 total selected automakers for information on the technologies within our scope. Specifically, we identified whether the automakers' websites on driver assistance technologies presented information on the capabilities and limitations of the selected technologies. We selected automakers based on the largest sales volumes in the U.S. and those that used multiple driver assistance technologies included in our scope. To review vehicle owner's manuals, we used the vehicle models selected for our undercover visits described below. We also interviewed selected automakers, as described above, about the ways in which they provide information on driver assistance technologies to consumers.

To provide non-generalizable, illustrative examples of how retailers educate consumers about driver assistance technologies, we conducted undercover visits to 10 selected retail locations in Maryland and Virginia, to inquire about crash avoidance technologies and partial driving automation systems. We selected one vehicle model from each selected automaker to enquire about on these visits, choosing a model that cost around $50,000 or less, included multiple technologies within our scope, and had high sales volume. We used a directory of retail locations in the Washington, D.C. area to randomly select one retail location for each selected automaker.

To evaluate how NHTSA contributes to consumers' use and understanding of driver assistance technologies, we reviewed NHTSA

rulemaking documents and information about driver assistance technologies on the agency's website. We also interviewed NHTSA officials about the agency's current and proposed educational and outreach efforts. We assessed NHTSA's contributions to consumer understanding against the agency's strategic goals and the information and communication component of internal control, which states that management should externally communicate the necessary quality information to achieve the entity's objectives.[5] We also assessed NHTSA's contributions according to leading project schedule management practices identified by the Project Management Institute (PMI) in *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*.[6]

See appendix I for more information on our objectives, scope, and methodology, including a list of all interviewees.

We conducted this performance audit from September 2022 to March 2024 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. We conducted our related investigative work in accordance with standards prescribed by the Council of the Inspectors General on Integrity and Efficiency.

Background

Driver Assistance Technologies

Driver assistance technologies include crash avoidance technologies and driver support systems. Crash avoidance technologies include both those

[5]U.S. Department of Transportation, *National Roadway Safety Strategy* (Washington, D.C.: January 2022); GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

[6]Project Management Institute, Inc., *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, Sixth Edition (Newtown Square, Pa.: 2017). PMBOK is a trademark of Project Management Institute, Inc. PMI is a not-for-profit association that provides global standards for, among other things, project and program management. These standards provide guidance on how to manage various aspects of projects, programs, and portfolios.

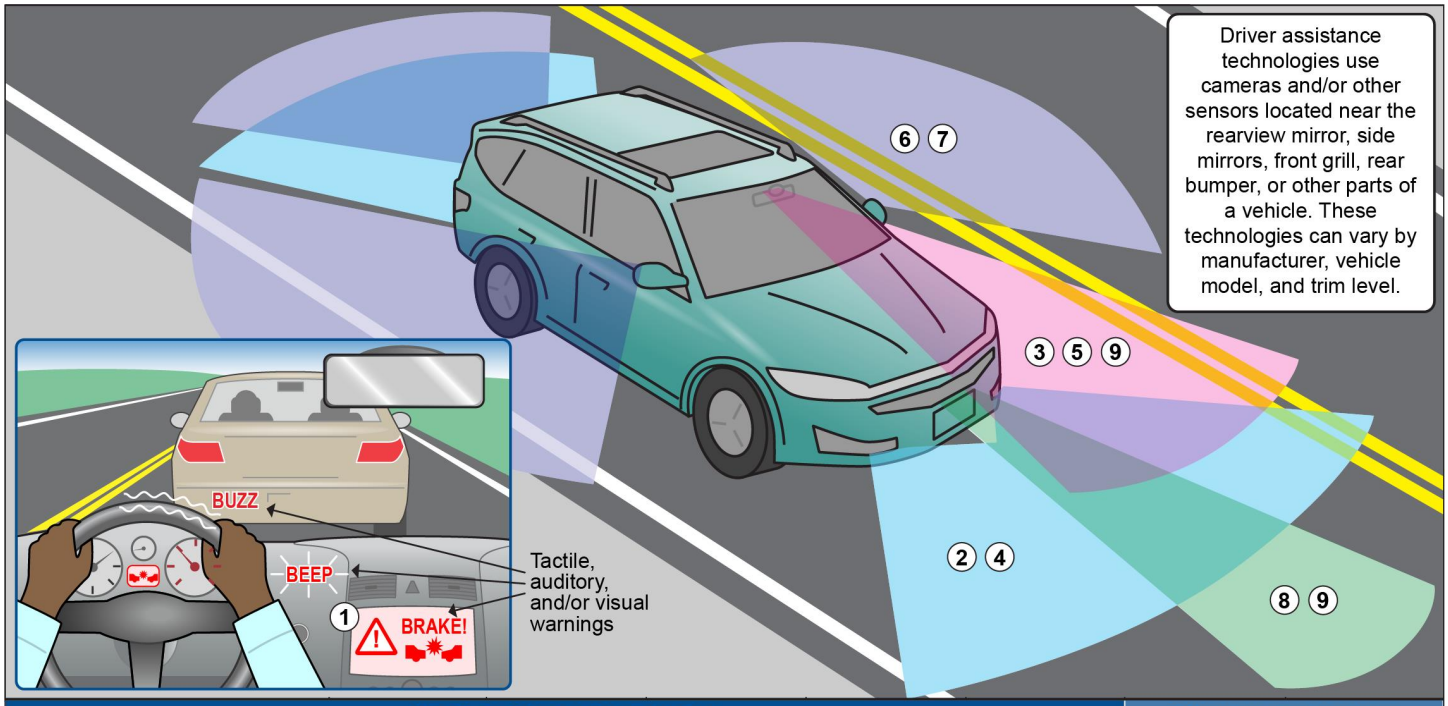
that warn a driver of the risk of a potential crash to prompt the driver to take action (e.g., forward collision warning and lane departure warning) as well as technologies that intervene to prevent or mitigate a crash (e.g., automatic emergency braking). NHTSA data show that crash avoidance technologies have the potential to increase safety by preventing crashes that might otherwise lead to injury or death. However, achieving these potential safety benefits requires that consumers who purchase vehicles equipped with these technologies keep the technologies activated and use them as intended.

Driver assistance technologies help drivers with some driving tasks at varying levels of automation.[7] Technologies that automate some driving tasks are known as driver support systems, and they are considered convenience features because the extent to which they improve safety is not yet known. These systems include adaptive cruise control and lane centering, which together comprise partial driving automation systems. Such systems require the driver to remain engaged as they may need to intervene quickly in certain situations. Drivers who misunderstand their role in using these systems could compromise safety.

Driver assistance technologies may use cameras and possibly other sensors throughout the vehicle to detect other vehicles, hazards, and traffic control devices such as road signs and pavement markings. Depending on their intended function, the technologies may communicate warnings to the driver through visual, auditory, or tactile alerts, or intervene directly in braking or steering to prevent a collision or automate some driving tasks. See figure 1 for descriptions of selected driver assistance technologies.

[7]SAE International, a standards development organization for automotive and other mobility industries, has defined levels of driving automation on a scale from 0 to 5, with 5 representing fully automated driving. NHTSA frequently references SAE driving automation levels and has used them in some documents issued by the agency. The only levels of automation available in cars currently sold throughout the U.S. are 0 through 2. Systems at these levels require the driver to remain engaged at all times to maintain safety. SAE International, *Surface Vehicle Recommended Practice: Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles,* J3016 (Revised April 2021).

Figure 1: Descriptions of Selected Driver Assistance Technologies

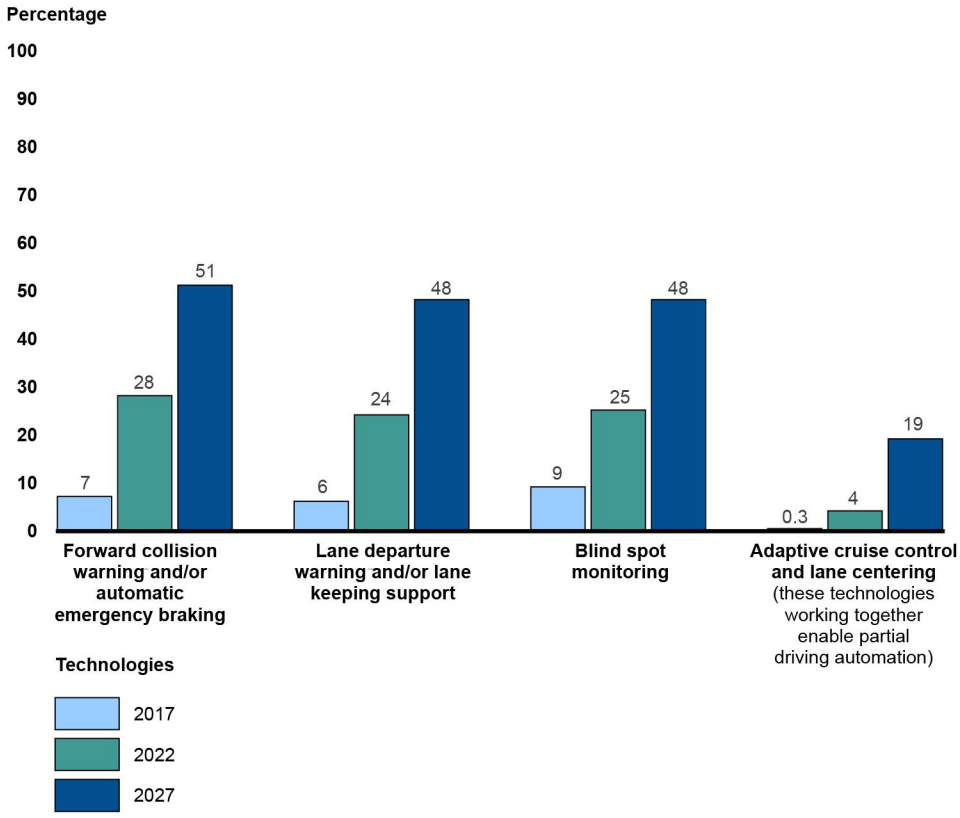


Crash avoidance technologies							Driver support systems	
1	2	3	4	5	6	7	8	9
Forward collision warning	**Automatic emergency braking**	**Lane departure warning**	**Pedestrian automatic emergency braking**	**Lane keeping support**	**Blind spot warning**	**Blind spot intervention**	**Adaptive cruise control**	**Partial driving automation system**
Alerts the driver to brake to prevent a potential frontal crash.	Automatically brakes when sensors determine that a frontal crash is imminent and the driver has not braked. (includes crash imminent braking and dynamic brake support).	Alerts the driver when the system detects that the vehicle is laterally approaching or crossing the lane markings.	Automatically brakes when sensors detect a pedestrian is in front of the vehicle and the driver has not acted to avoid the impending impact.	Actively guides a drifting vehicle back into the travel lane by gently counter steering or braking.	Warns the driver when a vehicle in an adjacent lane is approaching or being operated within the blind spot of the driver's vehicle.	Intervenes by either automatically braking or steering to guide the vehicle back into the unobstructed lane when an alert is ignored.	Automatically adjusts the vehicle's speed to maintain a pre-set distance to the vehicle in front of it, within a pre-set speed cap.	Controls both speed and steering simultaneously on a sustained basis, with the driver's supervision.
Recommended by NHTSA's New Car Assessment Program (NCAP)			**NHTSA has proposed recommending these technologies through NCAP**				**Driver support systems are not being considered for NCAP**	

Sources: GAO analysis of National Highway Traffic Safety Administration (NHTSA) information; GAO (illustration and icons). | GAO-24-106255

New vehicles are increasingly equipped with multiple driver assistance technologies. The Highway Loss Data Institute estimated that in 2027, 51 percent of U.S. registered vehicles will be equipped with at least some of these technologies, up from 28 percent in 2022 (see fig. 2).[8]

Figure 2: Estimated Percentage of U.S. Registered Vehicles with Selected Driver Assistance Technologies, 2017, 2022, and 2027



Source: GAO presentation of Highway Loss Data Institute data. | GAO-24-106255

[8]"Predicted availability of safety features on registered vehicles – a 2023 update," *Highway Loss Data Institute Bulletin*, vol. 40, no. 2 (April 2023).

Accessible Data Table for Figure 2

Year	2017	2022	2027
Forward collision warning and/or automatic emergency braking	7	28	51
Lane departure warning and/or lane keeping support	6	24	48
Blind spot monitoring	9	25	48
Adaptive cruise control and lane centering (these technologies working together enable partially automated driving)	0.3	4	19

Source: GAO presentation of Highway Loss Data Institute data. | GAO-24-106255

Federal and State Roles in Vehicle Safety

NHTSA is the lead federal agency involved in regulating, and educating the public about, driver assistance technologies. NHTSA's mission is to save lives, prevent injuries, and reduce economic costs due to road traffic crashes through education, research, safety standards, and enforcement.[9] NHTSA uses several approaches to carry out its mission, including:

- **Issuing regulations.** NHTSA sets the Federal Motor Vehicle Safety Standards, which are regulatory standards that specify the federal minimum performance requirements with which motor vehicles and motor vehicle equipment must comply to be sold in the U.S.[10] Some of these safety standards specify crash avoidance requirements, such as those related to brakes, and others specify crashworthiness requirements—such as seat belts—which are meant to reduce injury and death resulting from crashes. Automakers self-certify that their vehicles meet the applicable performance requirements of the federal safety standards. Currently there are no federal safety standards for

[9]NHTSA has been delegated DOT's authority over motor vehicle safety, which is primarily codified at 49 U.S.C. Chapter 301.

[10]The vehicle safety standards are located in 49 C.F.R. Part 571. Manufacturers must certify that their motor vehicles or motor vehicle equipment comply with applicable safety standards before their motor vehicles or motor vehicle equipment can be manufactured for sale, sold, introduced or delivered for introduction into interstate commerce or imported in the U.S. 49 U.S.C. §§ 30112, 30115.

driver assistance technologies within the scope of this report.[11] However, in June 2023, NHTSA issued a notice of proposed rulemaking indicating the intent to require three of these technologies—forward collision warning, automatic emergency braking, and pedestrian automatic emergency braking systems—on passenger cars and light trucks.[12]

- **Investigating defects and recalls.** NHTSA conducts vehicle safety investigations when it has evidence, such as from consumer complaints or a pattern of vehicle crashes, that a vehicle might have a safety problem. NHTSA may require a recall if it finds that a vehicle fails to comply with safety standards or contains a defect related to vehicle safety. In 2022, NHTSA oversaw 56 recalls for defects related to driver assistance technologies.
- **Maintaining a consumer information program.** NHTSA established NCAP in 1978 to provide comparative information annually on the safety performance of new vehicles. According to NHTSA, the aim of NCAP is to assist consumers with vehicle purchasing decisions and to encourage vehicle manufacturers to make safety improvements and add new safety features. NHTSA uses a five-star safety rating system to indicate a vehicle's crashworthiness; that is, how well the vehicle protects drivers and passengers during front and side crashes and how well vehicles resist rollovers. NHTSA uses checkmarks to indicate whether a vehicle comes equipped with recommended crash avoidance technologies that meet NHTSA's performance criteria. Safety ratings of vehicle crashworthiness are available to consumers by searching for specific vehicles on NHTSA's website. The ratings are also displayed on the new vehicle window sticker (called the Monroney label), which is required to be attached to vehicles at the point of sale. Checkmarks indicating the presence of crash avoidance technologies are only displayed on the pages for specific vehicles on NHTSA's website.

  Over the years, NHTSA has modified the recommended crash avoidance technologies as it incorporated some technologies, such as electronic stability control, into Federal Motor Vehicle Safety

[11]NHTSA issued Federal Motor Vehicle Safety Standards for other driver assistance technologies that do not fall within the scope of this report, such as those that require vehicles to have electronic stability control and rear visibility systems.

[12]Federal Motor Vehicle Safety Standards: Automatic Emergency Braking Systems for Light Vehicles, 88 Fed. Reg. 38,632 (June 13, 2023). NHTSA also issued in 2023 a notice of proposed rulemaking that would require automatic emergency braking on heavy vehicles. Heavy Vehicle Automatic Emergency Braking: AEB Test Devices, 88 Fed. Reg. 43,174 (July 6, 2023).

Standards. In March 2022, NHTSA requested comments on proposed updates to NCAP, including recommending four additional crash avoidance technologies. NHTSA also requested comments on other planned changes, including increasing the stringency of tests for currently recommended technologies and developing a new rating system to encompass the recommended crash avoidance technologies.[13]

- **Conducting safety campaigns.** NHTSA creates slogans, logos, images for print and internet use, and videos available online, which are developed as media campaigns to increase safety by changing driver behavior. These media resources are available for state and local governments and traffic safety stakeholders to use. “Click It or Ticket” is an example of a campaign to encourage seat belt use. NHTSA has created a set of videos to promote awareness and use of available crash avoidance technologies, including lane keeping assistance and blind spot intervention.
- **Conducting research.** NHTSA plans and implements research programs to further the agency’s goals to reduce crashes, fatalities, and injuries. As part of its broader research program, it conducts research related to driver assistance technologies, including evaluating the potential benefits of new and existing technologies. NHTSA also conducts research on behaviors and attitudes in highway safety, which it uses to develop countermeasures to deter unsafe behaviors and promote safe alternatives.

FTC collects consumer complaints about unfair and deceptive acts or practices in or affecting commerce, and can conduct investigations and take enforcement actions, including in matters relating to vehicle driver assistance technologies. Such acts or practices include a material representation, omission, or practice—including through the

[13]New Car Assessment Program, 87 Fed. Reg. 13,452 (Mar. 9, 2022). We provide an update on the status of these proposals and plans later in this report. While NCAP does not currently rate the performance of driver assistance technologies, some other entities have established rating programs for them. For example, both the European New Car Assessment Programme (Euro NCAP) and Japan New Car Assessment Program (JNCAP) began rating the performance of vehicles’ automatic emergency braking and lane keeping assistance systems in 2018. In 2020, Euro NCAP updated its ratings for partial driving automation systems to reflect the systems’ driver engagement and monitoring effectiveness and how well manufacturers communicated information to consumers about the capabilities and limitations of the systems. Similarly, in the U.S., the Insurance Institute for Highway Safety rates vehicles’ automatic emergency braking and forward collision warning systems and has begun to rate partial driving automation systems’ safeguards in 2024.

dissemination of marketing materials—that is likely to mislead a consumer acting reasonably in the circumstances.

State governments also play a role in regulating and educating consumers about driver assistance technologies. For example, some states may specify whether driver assistance technologies may be used in driver licensing examinations or provide information about the technologies and rules regarding their use to first responders. The American Association of Motor Vehicle Administrators published guidance for states on incorporating driver assistance technologies in driver skills testing, examiner training, and jurisdictional driver's manuals.[14] In 2022, California enacted legislation prohibiting automakers or retailers from misleading consumers about the capabilities of driver assistance technologies.[15] In January and June 2023, Nevada and California, respectively, permitted the operation of Mercedes-Benz's SAE Level 3 conditional driving automation system, which can perform the entire dynamic driving task in limited conditions. When Level 3 automation is activated, a driver may engage in non-driving tasks but must remain receptive to (1) system requests to resume control of the vehicle or (2) to vehicle system failures.

As we previously reported, the introduction of vehicles with higher levels of automation could affect traditional federal and state roles as the vehicle takes on more of the driving function.[16] For example, our previous work noted a potential grey area in the state's role if the driving function is controlled by software, rather than a licensed driver.

[14]American Association of Motor Vehicle Administrators, *Guidelines for Testing Drivers in Vehicles with Advanced Driver Assistance Systems* (Arlington, VA: August 2019).

[15]2022 Cal. Stat. 4863-64.

[16]GAO, *Automated Vehicles: Comprehensive Plan Could Help DOT Address Challenges,* GAO-18-132 (Washington, D.C.: Nov. 30, 2017).

Research Suggests Consumers May Not Fully Understand or Use Some Driver Assistance Technologies as Intended

Consumers May Not Fully Understand the Capabilities and Limitations of Driver Assistance Technologies

There is some evidence that consumers do not always have an awareness or accurate understanding of various driver assistance technologies' capabilities and limitations. We reviewed nine studies that surveyed drivers on their knowledge of driver assistance technologies and found:

- **Consumers revealed gaps in their awareness about driver assistance technologies.** For example, according to one study, about one-third of surveyed respondents said they had little to no knowledge about the driver assistance technologies on the vehicles they owned.[17] A different study found that around one-quarter or more of respondents could not provide an accurate description of automatic emergency braking, lane departure warning, blind spot warning, or adaptive cruise control.[18]
- **Consumers had misperceptions about the capabilities and limitations of driver assistance technologies.** For example, one study found that 27 percent of survey respondents did not understand that lane departure warning will not alert if a turn signal is active while drifting in that direction; 33 percent did not understand that automatic emergency braking relies on sensors or cameras that may be blocked by dirt, ice, or snow; and 79 percent did not know that blind spot warning systems are not designed to detect vehicles passing at

[17]Sophie Le Page et al, "Driver perceptions of advanced driver assistance systems and safety," version 3 (arXiv Sept. 23, 2021), accessed September 28, 2023, https://arxiv.org/abs/1911.10920. Results were based on an online survey of 1,018 U.S. drivers.

[18]Ian J. Reagan et al, "New and used vehicle buyers' awareness, understanding, and trust in advanced driver assistance systems," *Transportation Research Part F: Psychology and Behavior,* vol. 92 (2023): 44. https://doi.org/10.1016/j.trf.2022.11.009. Results were based on a sample of 764 survey respondents.

extremely fast speeds.[19] Two other studies found misconceptions about lane keeping assistance among drivers; for example, in one study of 364 recruited drivers, nearly one third of respondents did not know that the technology has difficulty operating when lane markings are faded or missing, and more than half were unaware that it may not work well on curvy roads.[20]

Another study we reviewed indicated that users of partial driving automation systems may have a poor understanding of the technology's limits.[21] In this study, between 12 percent and half of participants who owned vehicles with three different partial driving automation systems reported feeling comfortable allowing the system to drive the car without watching the road. Furthermore, a larger number of participants felt comfortable engaging in non-driving activities, such as texting and watching videos, while the systems were active than when the systems were not active.

Our non-generalizable review of consumer complaints to NHTSA also found instances where some consumers appear to have not understood the limitations of driver assistance technologies. Of the selection of 230 complaints we reviewed that related to driver assistance technologies, we found 30 instances that could illustrate a mismatch between driver expectations and potential capabilities and limitations of these technologies (see text box).

[19]Ashley McDonald, Cher Carney, and Daniel V. McGehee, *Vehicle Owners' Experiences with and Reactions to Advanced Driver Assistance Systems,* (Washington, D.C.: AAA Foundation for Traffic Safety, September 2018). Results were based on 1,380 survey responses.

[20]Chelsea A. DeGuzman and Birsen Donmez, "Knowledge of and trust in advanced driver assistance systems," *Accident Analysis and Prevention,* vol. 156 (2021), https://doi.org/10.1016/j.aap.2021.106121.

[21]Alexandra S. Mueller, Jessica B. Cicchino, and Joseph V. Calvanelli, Jr., *Habits, attitudes, and expectations of regular users of partial driving automation systems,* (Arlington, VA: Insurance Institute for Highway Safety, 2022). Results were based on a mixed-mode survey of 604 respondents.

Examples of Consumer Complaints to the National Highway Traffic Safety Administration (NHTSA) About Their Experiences with Driver Assistance Technologies

"I fell asleep while driving on a residential side street. The vehicle drifted over to the right side of the road and I hit the back end of a … truck. I didn't hear any warning and I don't believe the automatic braking system worked to prevent a collision with such severe damage. … My car has been in the … body shop since the accident … They … decided to total the car…"

"I was driving on the freeway with the lane keep assist and adaptive cruise control engaged. The system worked fine for a while but when I took my eyes off the road for a quick minute to grab something from the back seat, the system either disengaged without a warning or decided to steer to the left out of the lane, because in that short time, it moved two lanes to the left and hit the road barrier deploying the airbags and causing injuries to the passengers. The vehicle was declared a total loss. There were no warnings before or during the incident to indicate any kind of issue. I believe the … software on the … [vehicle model] is quite buggy as a similar incident happened a few months prior when the car randomly decided to take an evasive action to the right when there was no one else on the road. In that instance I was holding the steering wheel with my eyes on the road so I was able to apply immediate corrective action to prevent a mishap."

"On several occasions while driving on the highway, my … [brand-name] feature suddenly disengages and my cruise control ceases to work and no lane assist or other safety features contained within the … [brand-name] package work for extended periods of time. This has occurred when it is raining or snowing."

"The adaptive cruise control is scary. While it is expected that in especially hilly terrain that the cruise control would vary a bit (a couple of mph in either direction), the system sometimes does not engage, sometimes turns itself off without warning, provides inconsistent warning of when the vehicle interval is not maintained, but the biggest problem is that it does not maintain the set point. For example yesterday … set [adaptive cruise control] at 42 mph. [The] speed limit was 40 mph. I was descending a hill and manually disengaged the [adaptive cruise control] … when the vehicle speed exceeded 57 mph."

Source: GAO presentation of NHTSA information. | GAO-24-106255

Stakeholders from safety and consumer groups we met with told us that consumers might misunderstand the capabilities and limitations of driver assistance technologies for a few different reasons, including differences among vehicles and terminology. One recurring theme we heard from stakeholders is that crash avoidance technologies are implemented differently across manufacturers, models, and even model years of vehicles. For example, the methods of alerts, how to adjust the technologies' settings, and which settings can be adjusted vary across vehicles. These differences can make it difficult to provide broad information that is useful to each consumer's particular vehicle.

In addition, according to some stakeholders, the lack of standard terminology for these technologies and the proliferation of varied nomenclature by different manufacturers has confused consumers. For example, AAA listed 18 unique names used by manufacturers for lane keeping assistance, such as "Active Steering Assist" and "Intelligent Lane

Intervention."[22] In 2019, a group of consumer safety and education organizations sought to standardize the terminology used by automakers, NHTSA, and other stakeholders.[23] However, NHTSA officials, automakers, and a couple of stakeholders from industry and safety groups identified some challenges related to this initiative, including that the technologies can have subtle differences that do not conform to standard terminology.

Several Factors Can Influence How Consumers Use or Choose Not to Use Driver Assistance Technologies

Stakeholder interviews and multiple studies we reviewed identified several factors that can affect consumers' use of driver assistance technologies. According to stakeholders and research we reviewed, when consumers have a realistic understanding of driver assistance technologies' capabilities and how they work, they are more likely to use them as intended.[24] When, however, consumers have an overdeveloped sense of trust in these technologies, they may rely too heavily on the technologies and use them in ways that the manufacturer did not intend. In addition, according to stakeholders and a few consumer survey-based studies, consumers' perceptions of the usefulness, reliability, and intrusiveness of driver assistance technologies can influence whether consumers use or deactivate the technologies.[25] While different consumers may make different decisions about how and when to use

[22]AAA, *Advanced Driver Assistance Technology Names: AAA's recommendation for common naming of advanced safety systems* (American Automobile Association, Inc., 2019).

[23]AAA et al, *Clearing the Confusion: Common Naming for Advanced Driver Assistance Systems*.

[24]See, for example, David G. Kidd and Ian J. Reagan, "Attributes of Crash Prevention Systems that Encourage Drivers to Leave Them Turned on," in *Advances in Human Aspects of Transportation,* ed. Stanton, N, (Springer, 2018), doi: https://doi.org/10.1007/978-3-319-93885-1_47; Dan Liang et al., "Examining Senior Drivers' Attitudes Toward Advanced Driver Assistance Systems After Naturalistic Exposure," *Innovation in Aging,* Vol. 4, no. 3 (2020): 1, https://doi.org/10.1093/geroni/igaa017; and Massachusetts Department of Transportation, *Impact of Advanced Driver Assistance Systems (ADAS) on Road Safety and Implications for Education, Licensing, Registration, and Enforcement*, Report No. 22-027 (Amherst, MA: March 2022).

[25]See, for example, McDonald, Carney, and McGehee, *Vehicle Owners' Experiences with and Reactions to Advanced Driver Assistance Systems*.

driver assistance technologies, our review found that these factors can play out differently depending on the type of driver assistance technology.

Consumers May Deactivate Certain Crash Avoidance Technologies

Stakeholders, automakers, and the literature we reviewed generally recognize that consumers do not always keep crash avoidance technologies activated, thereby reducing their safety benefits.[26] In five of the studies we reviewed, results showed that the participants were likely to turn off lane departure warning and lane keeping assistance most frequently. In these studies, between 40 and nearly 70 percent of lane departure warning and lane keeping assistance systems were observed or reported by survey respondents to be turned off, suggesting that consumers frequently deactivate them.[27] The five studies also found that consumers deactivate forward collision warning and automatic emergency braking, but to a much lesser extent—between less than 1 percent and around 20 percent of those systems were observed or reported to be turned off. We also found anecdotal evidence that some consumers turn off automatic emergency braking and other technologies in our review of consumer complaints to NHTSA, mainly due to the systems not working as they had expected.

[26]See, for example, Ian J. Reagan et al., "Crash avoidance and driver assistance technologies—are they used?," *Transportation Research,* vol. Part F, no. 52 (2018): 176*;* Ian J. Reagan and Anne T. McCartt, "Observed activation status of lane departure warning and forward collision warning of Honda vehicles at dealership service centers," *Traffic Injury Prevention,* vol. 17, no. 8 (2016): 827-832; David G. Kidd, et al., "Driver trust in five driver assistance technologies following real-world use in four production vehicles," *Traffic Injury Prevention,* vol. 18, no. S1 (2017), https://doi.org/10.1080/15389588.2017.1297532.

[27]For example, according to one survey of 1,212 owners of vehicles equipped with these technologies, around 40 percent reported turning off lane departure warning or lane keeping assistance, but only 11 percent reported turning off automatic emergency braking or forward collision warning. Findings from this study were based on responses from owners of specific 2016/17 vehicle models and cannot be used to make assumptions about the total population of vehicle owners. McDonald, Carney, and McGehee, *Vehicle Owners' Experiences with and Reactions to Advanced Driver Assistance Systems.* Two Insurance Institute for Highway Safety (IIHS)-funded studies observed the activation rates of these technologies in vehicles that were brought to dealerships for service. One study observed over 1,000 vehicles brought to a selection of dealerships across eight automakers and found that about half (49 percent) of the lane maintenance technologies were turned off, while most (93 percent) of front crash prevention systems were turned on. Reagan et al., "*Crash avoidance and driver assistance technologies—are they used?*"; Reagan and McCartt, "Observed activation status of lane departure warning and forward collision warning of Honda vehicles at dealership service centers."

Some of the studies we reviewed and stakeholders we interviewed identified factors that can influence whether consumers use or deactivate certain crash avoidance technologies.

- **Intervention versus warning and the type of warning.** One research study we reviewed found evidence that consumers tend to accept technologies that intervene in driving tasks more so than those that warn drivers.[28] Also, among the warning systems, the mode of alert can influence whether consumers keep them turned on. Results of a study showed participants were more likely to turn off auditory alerts such as beeps, compared with tactile alerts, such as wheel vibrations.[29]
- **Level of trust and understanding.** When a system does not act as a consumer expects or makes many errors—either by giving false alerts or failing to alert when warranted—the consumer can lose trust in the system and is less likely to use it.[30] A stakeholder that provides driving education to older drivers told us that many older drivers do not understand the crash avoidance technologies in their new cars and may turn them off because they find them distracting or frustrating. One other stakeholder we interviewed said that some consumers incorrectly believe they drive better without any crash avoidance technologies.

Most automakers we interviewed told us that they attempt to address these issues by improving the designs of their systems. A couple of automakers noted, however, that design choices involve a balance

[28]Researchers observed activation rates of technologies in 1,152 vehicles brought to dealerships for service and found that vehicles with lane keeping assistance were 35 percent more likely to have the system turned on than those with lane departure warning. Reagan et al., "Crash avoidance and driver assistance technologies—are they used?," 176. In its March 2022 request for comments, NHTSA stated that it believes active safety technologies are more effective than warning technologies, based in part on a study by the University of Michigan Transportation Research Institute. That study found that automatic emergency braking is more effective than forward collision warning alone, and that lane keeping support is more effective than lane departure warning. According to the study, consumer use of these systems may be an important factor in the systems' effectiveness. Andrew J. Leslie et al., *Analysis of the Field Effectiveness of General Motors Production Active Safety and Advanced Headlighting Systems,* Report No. UMTRI-2019-6 (Ann Arbor, MI: July 2019).

[29]Carol Flannagan et al., *Large-scale field test of forward collision alert and lane departure warning systems*, National Highway Traffic Safety Administration Report No. DOT HS 812 247 (Washington, DC: February 2016).

[30]See, for example, Liang et al., "Examining Senior Drivers' Attitudes Toward Advanced Driver Assistance Systems;" and Kidd, et al., "Driver trust in five driver assistance technologies following real-world use in four production vehicles."

between the sensitivity of the systems—which could provide more safety benefit but trigger false alarms—and making the systems more acceptable to drivers, so they are more likely to keep them turned on. NHTSA has also noted these issues affecting consumer acceptance of crash avoidance technologies and considers them in developing tests of whether vehicles meet criteria for the recommended technologies in NCAP.[31]

Evidence Suggests Some Consumers Misuse Partial Driving Automation Systems

According to 12 studies we reviewed and representatives from safety and industry organizations, some consumers misuse partial driving automation systems either by using them in conditions in which they were not designed to operate or by over-relying on them.

Unlike many crash avoidance technologies that are meant to always be kept on, in theory, partial driving automation systems are designed to be turned on only when conditions allow. Accordingly, many of these systems are intended to be used only on limited-access highways (i.e., U.S. and state numbered freeways, expressways, and Interstate routes where access is limited to exit and entrance ramps, and there are no intersections). Some may also have other limitations on their use, such as in low-visibility weather conditions or on curved or hilly roadways. However, a few studies we reviewed found that some drivers will use these systems wherever it is possible to activate them—even if the car owner manuals warn against it. For example, in one study involving a field test of approximately 50 drivers, some drivers frequently used the systems on roadways outside of where the systems were designed to operate, such as on arterial roads with intersections and heavy traffic.[32]

A few automakers have designed their partial driving automation systems to restrict when a consumer can activate them. For example, a few automakers use software that combines maps of roadways and GPS data to strictly limit system activation to relatively safe driving environments. While this effort reduces the likelihood of consumers using systems

[31]New Car Assessment Program, 87 Fed. Reg. 13,452 (March 9, 2022).

[32]Ian J. Reagan et al., "Measuring adult drivers' use of level 1 and level 2 driving automation by roadway functional class," *Proceedings of the Human Factors and Ergonomics Society 2019 Annual Meeting*.

outside of appropriate conditions, some automakers' systems are not limited and can be activated at any time.[33]

Even when operated within the intended conditions, research we reviewed found that drivers do not monitor automation systems or the driving task well, and consumers may over-rely on these systems. According to this research, drivers may find it difficult to remain engaged when their role is more passive and supervisory rather than active and hands-on. In addition, a synthesis of literature on driver distraction found that drivers increasingly engage in secondary tasks, such as eating, cell phone use, and looking at the scenery, when operating these systems.[34] In its investigation of a fatal vehicle collision in 2018, NTSB found evidence that a driver was playing a cell phone game when his vehicle's partial driving automation system steered the vehicle out of its traveling lane and crashed into a piece of highway infrastructure.[35] According to literature, critical situations arise quickly and unexpectedly, and if a driver's attention is diverted, they may be unable to intervene in time to avoid a collision.

According to the literature and stakeholders we interviewed, the likelihood of driver disengagement may be influenced by several factors, including:

- **The sophistication of the system.** According to research we reviewed, the more sophisticated these systems are at automating the driving task, the more likely drivers are to disengage from driving. For example, one study involving 10 drivers found that participants were more likely to engage in non-driving activities while using partial driving automation systems than while using systems with less automation, such as adaptive cruise control.[36]
- **The driver's level of trust.** Studies have indicated that as drivers develop trust in these systems, they feel more comfortable engaging

[33]Reagan et al., "Measuring use of driving automation by roadway functional class."

[34]Apoorva P. Hungund, Ganesh Pai, and Anuj Pradhan, "Systematic review of research on driver distraction in the context of advanced driver assistance systems," *Transportation Research Record,* Vol. 2675, no. 9 (2021): 756, DOI: 10.1177/03611981211004129.

[35]National Transportation Safety Board, *Collision Between a Sport Utility Vehicle Operating with Partial Driving Automation and a Crash Attenuator, Mountain View, California, March 23, 2018,* NTSB/HAR-20/01 (Washington, D.C.: February 25, 2020).

[36]Ian J. Reagan et al., "Disengagement from driving when using automation during a 4-week field trial," *Transportation Research Part F: Psychology and Behaviour,* vol. 82 (2021): 400, https://doi.org/10.1016/j.trf.2021.09.010.

in non-driving tasks.[37] Until they experience an adverse event, which may be infrequent with partial automation, these studies indicate that driver trust grows over time, leading to overreliance.

- **Branding and marketing.** One study that tested different types of learning protocols among 90 participants found that automakers' branding can impact consumer expectations of a partial driving automation system's capabilities.[38] According to the study, branding that emphasized a system's capabilities rather than its limitations led participants to report greater confidence in the system and increased the potential to use the system unsafely. Most stakeholders we interviewed described misleading information from vehicle marketing as influencing consumer perceptions of partial driving automation systems, which they said can lead to driver disengagement or misuse. In July 2022, the California Department of Motor Vehicles filed a complaint with its Office of Administrative Hearings seeking the suspension or revocation of an automaker's manufacturer license, alleging that the automaker's advertisements made untrue or misleading statements regarding the capabilities of its partial driving automation system. Some stakeholders suggested that FTC could address issues related to misleading information, but it has not announced any investigations of an automaker's advertising of driver assistance technologies.

Some vehicles with partial driving automation systems have driver monitoring systems, which are designed to help prevent drivers from over-relying on them. Driver monitoring systems use sensors or cameras to track the driver's head or eye gaze position and alert the driver to re-engage if needed, by touching the steering wheel for example.[39] Some driver monitoring systems will turn the partial driving automation off and block the driver from using it for a period of time if drivers ignore the warnings and do not re-engage in driving. Studies have found that driver monitoring systems are not equally effective at keeping drivers engaged, and there is information indicating that drivers have been able to

[37]See, for example, Mueller, Cicchino, and Calvanelli, *Habits, attitudes, and expectations of regular users of partial driving automation systems*.

[38]Jeremiah Singer and James W. Jenness, AAA Foundation for Traffic Safety, *Impact of Information on Consumer Understanding of a Partially Automated Driving System*, (Washington, D.C.: AAA Foundation for Traffic Safety, September 2020).

[39]Driver monitoring systems are available on some vehicles without partial driving automation to monitor driver drowsiness or distraction. According to one study, little more than half of vehicle manufacturers employ them. See Massachusetts Department of Transportation, *Impact of Advanced Driver Assistance Systems (ADAS) on road safety*.

circumvent some driver monitoring safeguards without re-engaging fully, such as by absentmindedly tapping the steering wheel.[40]

Consumer Reports and the Insurance Institute for Highway Safety (IIHS) have both published guidance and ratings on how well partial driving automation systems keep drivers engaged in driving.[41] IIHS separately rated each system's driver monitoring, attention reminders, and other safety features, such as whether crash avoidance technologies must remain on while partial driving automation is active. Euro NCAP also publishes ratings of driver monitoring systems and other aspects of how partial driving automation systems encourage drivers to pay attention to the driving environment.

In addition to installing driver monitoring systems, research we reviewed and a couple of stakeholders identified consumer training and information as ways to help combat misuse or overreliance on partial driving automation systems. A few studies found that training and information focused on the operation, capabilities, and limitations of these technologies improve drivers' level of understanding.[42] Since widescale in-person training may not be feasible, some studies suggested offering more practical options, such as written tutorials and recorded videos. Some studies concluded that it can be more effective to focus on improving consumers' overall understanding of the fallibility of the technologies and to reinforce how drivers should use the technologies, rather than provide detailed information on the specific operational limitations of a system.[43]

[40]See, for example, AAA, *Effectiveness of Driver Monitoring Systems* (February 2022).

[41]In its guidance, IIHS recommends that the ideal system would track multiple components, including eye gaze or head position, steering input, and the length of time for the driver to respond to attention reminders. See Alexandra S. Mueller, Ian J. Reagan, and Jessica B. Cicchino, "Addressing Driver Disengagement and Proper System Use: Human Factors Recommendations for Level 2 Driving Automation Design," *Journal of Cognitive Engineering and Decision Making*, 2021, DOI: 10. 1177/ 1555 3434 20983126.

[42]Martin Krampell, Ignacio Solís-Marcos, and Magnus Hjälmdahl, "Driving automation state-of-mind: Using training to instigate rapid mental model development," *Applied Ergonomics,* vol. 83 (2020): 102986. https://doi.org/10.1016/j.apergo.2019.102986; Dan Liang et al., "Examining Senior Drivers' Attitudes Toward Advanced Driver Assistance Systems."

[43]See, for example, DeGuzman and Donmez, "Knowledge of and trust in advanced driver assistance systems."

Selected Automakers Use Several Methods to Educate Consumers

Representatives from all eight automakers we met with told us they have varied approaches to conveying the capabilities and operational limitations of driver assistance technologies through their web pages, retailers, and owner's manuals.[44] For example, representatives from one automaker stated there are many ways to reach consumers, and their goal is to maintain consistency and capture consumers' varied preferences for how they access information. According to two surveys, consumers spend hours both researching vehicles online and visiting dealerships during the vehicle purchasing process. Vehicle owner's manuals are typically used after a vehicle has been purchased.[45] We found that automakers provided more information on capabilities of driver assistance technologies on their websites and through retailers, whereas owner's manuals included detailed information on both capabilities and operational limitations.

Conveying the Capabilities of Crash Avoidance Technologies

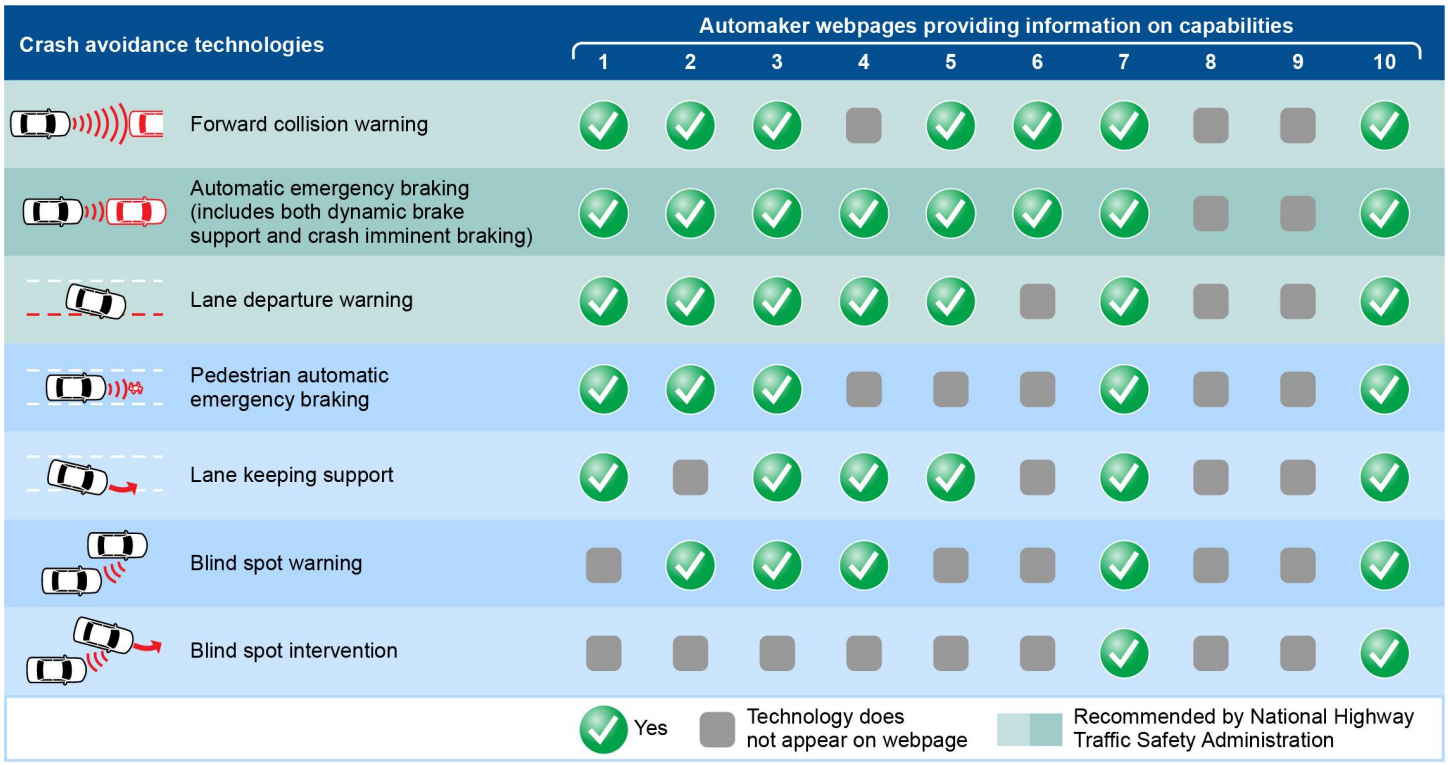
Most (eight of 10) automaker web pages we reviewed provided a description of the capabilities of at least one crash avoidance technology included in our scope (see fig. 3). Most of the automakers provided information on the technologies NHTSA currently recommends through

[44]We define capabilities as what the technologies can do and limitations as what the technologies cannot do and in what conditions they should not be used. The 10 automakers included in our scope manufacture vehicles equipped with most of the crash avoidance technologies and driver support systems we reviewed. We reviewed automaker web pages that generally address the range of driver assistance technologies offered across the manufacturer's fleet of new vehicles. We did not review web pages for specific technologies or vehicles. Automakers may also include information on technologies in other locations on their websites, which we did not review. Automakers have discretion on what is included on their web pages and other sources of information that consumers may access. See Appendix I for more information on our scope and methodology.

[45]According to Statista, a 2021 survey of consumers who had recently purchased or leased a vehicle found that new car buyers spent an average of 5 hours and 22 minutes on online automotive research and purchasing. Statista, *Average Time Spent Research and Shopping for Cars Online in the U.S. from 2019 to 2021*, January 2022. A 2023 Cox Automotive survey of over 10,000 consumers found that in 2022, consumers spent more than 8 hours online and almost 3 hours at a dealership when purchasing a vehicle. Cox Automotive, Research & Market Intelligence, *2022 Car Buyer Journey Study: Research Summary* (Cox Automotive, January 2023).

NCAP. For example, eight automakers included information about the capabilities of automatic emergency braking on their web pages.[46] Fewer automakers provided information on the technologies NHTSA proposes recommending through NCAP. For example, five automakers included information about pedestrian automatic emergency braking and two automakers included information about the capabilities of blind spot intervention. One automaker web page included only information on driver support systems (e.g., partial driving automation systems) and provided no information on crash avoidance technologies, such as forward collision warning and automatic emergency braking.

Figure 3: Number of Selected Automaker Web Pages That Provided Information on the Capabilities of Selected Crash Avoidance Technologies



Sources: GAO analysis of automaker websites and National Highway Traffic Safety Administration information; GAO (icons). | GAO-24-106255

Note: Our analysis focused on the primary web page each automaker used to describe its crash avoidance technologies. In cases where the technology did not appear on that web page, it is

[46]Twenty automakers, including those selected in our review, signed a voluntary commitment with NHTSA to install automatic emergency braking technology in at least 95 percent of new vehicles sold in the United States by the end of August 2023. According to IIHS, all 20 participating automakers fulfilled this commitment.

possible that information about the technology was available on another web page or that the automaker did not have this technology within its vehicle fleet. Web pages were reviewed from April 2023 to February 2024.

Automakers also varied in the level of detail they provided about certain crash avoidance technologies. For example, of the five automakers that included information about pedestrian automatic emergency braking, we found that descriptions were generally clearly stated, and in some instances provided graphics or videos of how the technology works. One web page provided a relatively high level of detail: it stated that front pedestrian braking can help avoid or reduce the severity of a front-end collision with a pedestrian by providing alerts and hard emergency braking or enhancing the driver's hard braking. The other four web pages included information about pedestrian automatic emergency braking as part of a larger pre-collision system. For example, one of the web pages explained that its system is designed to help detect a vehicle, pedestrian, bicyclist, or motorcyclist and provide an audio or visual forward-collision warning under certain circumstances. If the driver does not react, the system is designed to provide automatic emergency braking.

All 10 vehicle owner's manuals we reviewed provided descriptions of crash avoidance technology capabilities. For example, one manual stated that lane keeping support is capable of detecting visible lane markings or the road's edge at speeds above 30 mph and is designed to issue a visual alert and an audio or steering vibration alert if an inadvertent lane departure is detected. In another example, one manual showed an illustration of blind spot warning and how it uses rear corner radar to help detect approaching vehicles in the driver's blind spot areas and provides visual and auditory warnings of a possible collision.

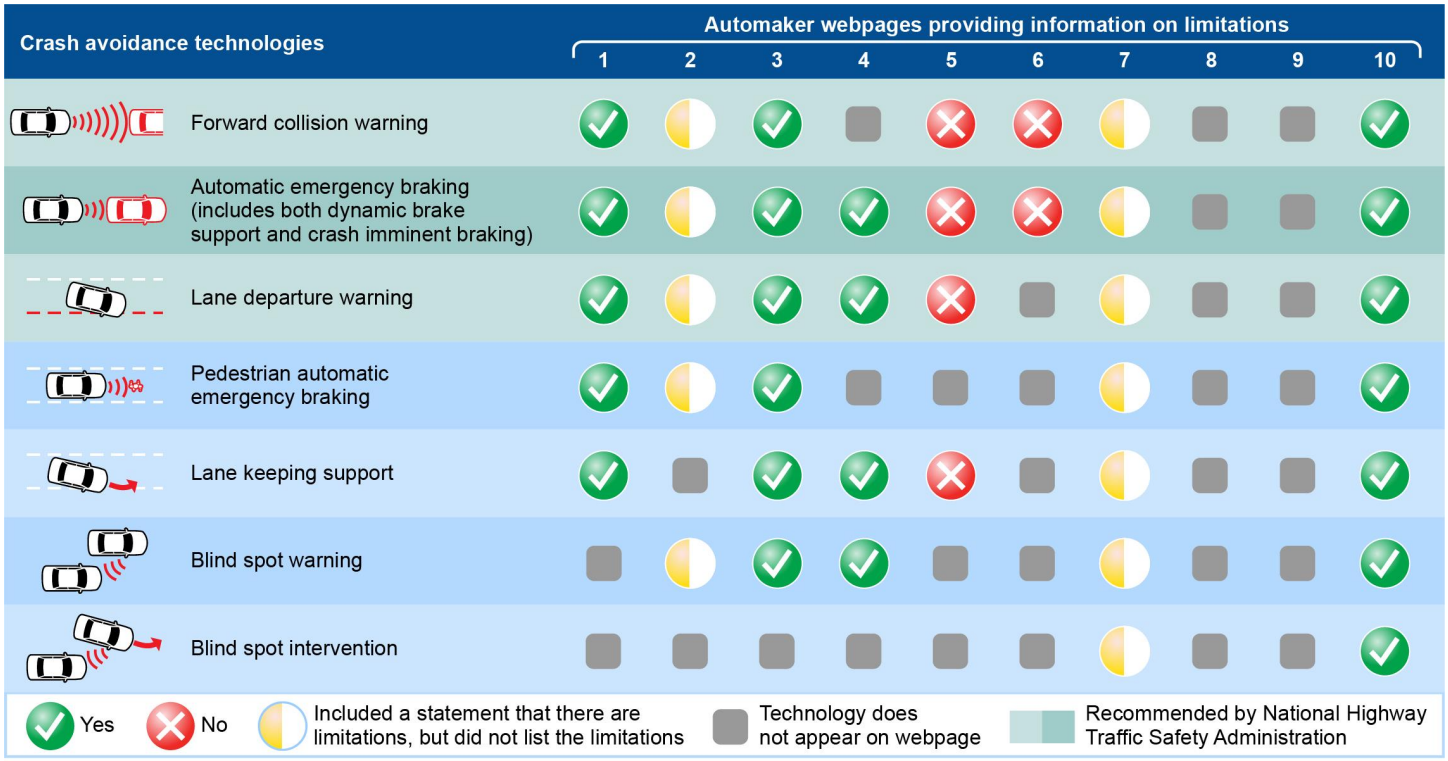
In addition, we found that information on the capabilities of crash avoidance technologies that was provided by salespeople varied based on our undercover retailer visits. This variation might be explained in part by automakers' engagement with retailers. All of the automakers we met with told us they provide retailers with training for salespeople. For example, one automaker told us they educate their sales personnel through training materials and videos. Another automaker told us they educate salespeople by providing direct experience with the technologies, since they believe that hands-on education is important. During our undercover visits to retailers, some salespeople explained the capabilities of some technologies. For example, one salesperson said that for blind spot monitoring, the side view mirrors will blink when an object is in your rear blind spot. In another example, one salesperson explained that the manufacturer's system for lane departure warning and lane keeping

support will make a noise, vibrate the seat, and yank the vehicle back in the lane if the vehicles starts to drift out of the lane without the turn signal engaged. However, in another instance, information from a salesperson on the technologies' capabilities was not clear.

Conveying the Operational Limitations of Crash Avoidance Technologies

Fewer automaker web pages we reviewed provided information on the operational limitations of the technologies as compared to their capabilities. In particular, about half of the automaker web pages we reviewed either provided partial or no information on the limitations of the technologies for which they included capabilities (see fig. 4). For example, one automaker (automaker 5 in fig. 4) provided information on capabilities for some of the selected technologies on their web page and not on the operational limitations for those technologies. Two automakers provided information on capabilities of most of the selected technologies and included a general disclaimer to describe operational limitations. In contrast, another automaker's web page provided both the capabilities and limitations for all the technologies included on their web page.

Figure 4: Number of Selected Automaker Web Pages That Provided Information on the Operational Limitations of Selected Crash Avoidance Technologies



Sources: GAO analysis of automaker websites and National Highway Traffic Safety Administration information; GAO (icons). | GAO-24-106255

Note: Our analysis focused on the primary web page each automaker used to describe its crash avoidance technologies. A "no" indicates that the automaker listed the technology on its website but did not provide information on its operational limitations. In cases where the technology did not appear on the web page, it is possible that information about the technology was available on another web page or that the automaker did not have this technology within its vehicle fleet. Web pages were reviewed from April 2023 to February 2024.

Automaker web pages that included information about the limitations of crash avoidance technologies varied in their descriptions of them. For example, of the three automakers that provided information on the limitations of lane keeping support, one of the web pages provided several examples of how performance of the technology could be affected, including by visibility, weather, and road conditions. The other web pages provided more general information about the limitations or conditions that may affect performance, and one of the web pages referred consumers to the owner's manual for more information.

All 10 vehicle owner's manuals we reviewed provided comprehensive information about the operational limitations of crash avoidance technologies. For example, one manual stated that lane departure

warning is designed to alert the driver if the vehicle is drifting out, or nears the edge, of the driving lane. This manual also described the operational limitations of the lane departure warning, stating that the system cannot always detect lane markings, and the driver may experience unnecessary or invalid warnings in certain conditions, such as in heavy rain, snow, or fog or if a bright light (such as from oncoming headlights or direct sunlight) interferes with the view of the system's cameras. In another example, one manual stated that the pedestrian automatic emergency braking system may help avoid or reduce the harm caused by front-end crashes with nearby pedestrians when driving in a forward gear. The manual stated that the system is able to detect and alert the driver to pedestrians at speeds between 5 and 50 miles per hour and up to a distance of approximately 131 feet during daytime driving. The manual also stated that system performance is very limited at nighttime and that the technology may not detect all pedestrians, including specific difficulties with detecting children, pedestrians not directly ahead of the vehicle, or each individual pedestrian when part of a group. All 10 manuals included graphics or illustrations to show the capabilities or limitations of the technologies.

At the retailers we visited during our undercover investigation, some salespeople provided some information, when asked, on the limitations of crash avoidance technologies, but the information was not always clear. One salesperson said that there are no restrictions for using lane keeping support, but that it depends on the car. In another example, when asked about any conditions in which certain technologies, such as lane keeping support, would not work, such as in snow, one salesperson said it would not matter "if it snows, sleet, rain, none of that, unless it's a really, really bad, terrible storm."

Conveying the Capabilities, Operational Limitations, and Driver's Role in Partial Driving Automation Systems

We found that automakers had varied approaches to conveying the capabilities and operational limitations of partial driving automation systems through their web pages, retailers, and owner's manuals. Our review of automaker web pages also analyzed whether the web pages included information about the role of the driver because, as previously discussed, consumers may be more likely to engage in non-driving tasks when using partial driving automation systems. Most of the automakers included in our scope equip at least some of their vehicles with partial driving automation systems. In addition, most of the automaker web

pages provided information about the capabilities of partial driving automation, and some of these automakers also provided information on operational limitations and the driver role. The owner's manuals that included information about these systems also included detailed information about the operational limitations of the systems and the role of the driver.

System capabilities. The automaker web pages that provided information on the systems' capabilities did so in a variety of ways. For one automaker, while it equips some vehicles with partial driving automation systems, the web page refers to the underlying systems of partial driving automation (i.e., adaptive cruise control and lane centering). Representatives from this automaker told us they emphasize that the systems only assist the driver so that consumers better understand that the vehicle is not intended to take over the driving task. The other automakers described the capabilities of their systems in a variety of ways. For example, according to one automaker's web page, its partial driving automation system "with an attentive driver, and under the proper conditions, can permit hands-free operation of the vehicle." It also stated that the system uses real-time cameras, sensors, and map data to help detect curves.

Another automaker web page stated that its partial driving automation system "automatically helps keep you centered in your lane and traveling at a safe distance behind the car ahead." The web page also stated that "[the system] also can keep you driving at the right speeds, automatically setting your pace based on GPS and highway data. The owner's manuals that included information on partial driving automation systems provided detailed information about the systems' capabilities and how the systems operate.

System limitations. Five of the automaker web pages included information about operational limitations of partial driving automation. Of the five, two of the web pages stated that the systems should not be activated during difficult or uncertain driving conditions, such as when lane markings are poor or visibility is limited, in construction zones, or on slippery roads. On a third web page, clicking on an asterisk in the main text displayed the following pop-up message: "System effectiveness depends on many factors, such as speed, size and position of detected objects and weather, light and road conditions. See Owner's Manual for additional limitations and details." The other two web pages included partial information about limitations; they noted that there are limitations but did not provide examples. The automaker's owner's manuals that

included information about partial driving automation systems included information on the systems' limitations. For example, one owner's manual included pages of limitations and warnings. We also asked about system limitations during our undercover visits to retail locations. During one visit a salesperson told us that the system would basically drive itself unless the road was covered in snow, as it relies on lane markings to operate.

Driver role. Five of the automaker web pages included information about the driver's role. For example, one web page stated that "driver assist features are supplemental and do not replace the driver's attention, judgement and need to control the vehicle. It does not replace safe driving. See owner's manuals for details and limitations." Another automaker website included the following statements: "[A]lways pay attention while driving and when using [the system]" and "do not use a handheld device." As with the system limitations, the owner's manuals we reviewed that included information on partial driving automation systems also included information about the role of the driver. During some of our undercover retailer visits, when asked about the partial driving automation systems, salespeople generally said that the driver must always remain alert.

NHTSA Provides Information to Consumers about Some Driver Assistance Technologies, but Excludes Some Key Information and Has Missed Time Frames for NCAP Updates

NHTSA Educates Consumers about Vehicle Safety through NCAP but Does Not Provide Key Information on Driver Assistance Technologies

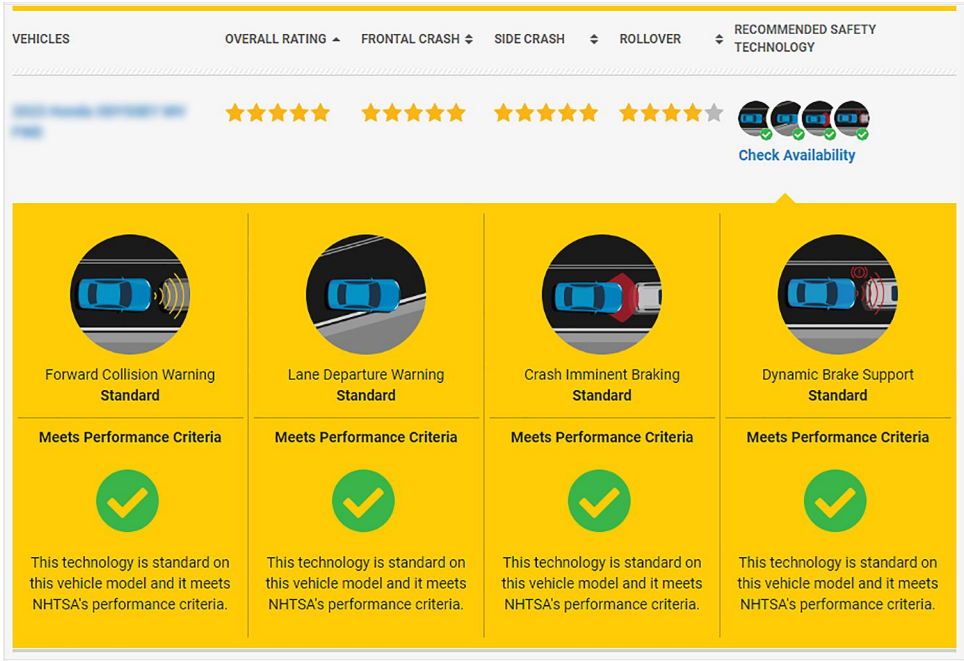
NHTSA educates consumers about driver assistance technologies through NCAP, additional information on its website, and other efforts. However, we found that NHTSA's website did not provide clear and complete information to consumers on how it determines whether vehicles' crash avoidance technologies meet NHTSA's criteria. Moreover, NHTSA did not offer complete information about partial driving automation systems on its website.

New Car Assessment Program

As previously described, NHTSA recommends four crash avoidance technologies through NCAP: (1) forward collision warning, (2) lane departure warning, (3) crash imminent braking, and (4) dynamic brake support.[47] NHTSA does not rate the performance of these technologies in its five-star safety ratings program, but it uses checkmarks to indicate whether a vehicle is equipped with each recommended technology and, if so, whether it meets NHTSA's performance criteria (see fig. 5). To view which vehicle models are equipped with the four crash avoidance technologies NHTSA recommends, consumers must search the database on NHTSA's website for specific vehicles.

[47]Crash imminent braking and dynamic brake support are also referred to as automatic emergency braking. In July 2008, NHTSA began recommending forward collision warning and lane departure warning as part of NCAP. Consumer Information; New Car Assessment Program, 73 Fed. Reg. 40,016, 40,033 (July 11, 2008). These changes were implemented beginning with model year 2011 vehicles. Consumer Information; New Car Assessment Program (NCAP), 73 Fed. Reg. 79,206, 79,206 (Dec. 24, 2008). In November 2015, NHTSA began recommending crash imminent braking and dynamic brake support as part of NCAP (effective for model year 2018 vehicles). New Car Assessment Program *(NCAP)*, 80 Fed. Reg. 68,604, 68,604 (Nov. 5, 2015).

Figure 5: Example of Vehicle Rating That Includes Recommended Checkmarks for Crash Avoidance Technologies on NHTSA's Website



Source: National Highway Traffic Safety Administration (NHTSA). | GAO-24-106255

According to NHTSA, automakers submit self-reported test data confirming their vehicles meet NHTSA's performance criteria, and NHTSA adds the recommended checkmark to the website for each vehicle as appropriate. Each year, NHTSA conducts tests to verify the performance of these technologies in a sample of vehicle models. According to data provided by NHTSA officials, NHTSA has selected an average of 16 different vehicle models to test for each model year over the past 6 years. Based on its testing, over the past 5 years, NHTSA has removed a recommended checkmark from an average of two vehicles per year that did not meet NHTSA's performance criteria.

NHTSA's website, however, does not provide information about the test conditions and performance criteria used to determine whether a vehicle's technologies qualify for a checkmark. For example, NCAP tests lane departure warning systems at speeds of 45 mph and requires the systems to issue alerts for 20 of the 30 trial runs conducted to pass the test. Because the website only indicates whether the technology meets NCAP criteria, consumers may overestimate the technology's capabilities believing, for example, that it is or is near fail-proof when, in fact, the

performance criteria require a 66 percent success rate at below highway speeds.

The statute underlying NCAP requires NHTSA to communicate certain vehicle safety information to the public.[48] Among other information, DOT is to provide the public with information on crash avoidance, crashworthiness, and damage susceptibility. Such information is to be provided in a simple and understandable format to allow comparison among vehicles to assist a consumer in buying a new car.[49] In addition, *Standards for Internal Control in the Federal Government* state that entities should externally communicate the necessary quality information to achieve their objectives.[50] By indicating on its website which vehicles have technologies that meet NHTSA's criteria—without providing information about the test conditions and performance criteria—NHTSA is not communicating the necessary quality information to achieve its objectives. Information about the test conditions and performance criteria is necessary for consumers to have a more realistic understanding of the capabilities of the recommended crash avoidance technologies and would also enable consumers to make more informed purchasing decisions.

NHTSA officials agreed that a brief description on its website of the test conditions and performance criteria for testing the crash avoidance technologies would be useful for consumers. According to NHTSA officials, the performance criteria underlying the checkmark is available to the public through the Federal Register.[51] Further, they said the agency plans to provide information in the "frequently asked questions" on its NCAP ratings website on test procedures and crash avoidance testing programs. However, neither the Federal Register nor the "frequently asked questions" page is where consumers directly access vehicle safety information available through NCAP.

[48]The Secretary of Transportation is required to provide the public with information on certain passenger motor vehicle characteristics including crash avoidance, crashworthiness, and damage susceptibility. 49 U.S.C. § 32302(a)-(b).

[49]49 U.S.C. § 32302(b).

[50]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

[51]In March 2022, NHTSA requested comments on a number of changes to increase the stringency of the performance criteria for these recommended technologies, among other proposed updates to NCAP. However, NHTSA did not request comments about communicating performance criteria on its website for the enhanced performance criteria.

NHTSA currently provides simple information about the test conditions used to determine a vehicle's crashworthiness star rating on its consumer-facing website. For example, for the overall side star rating, consumers can click for a short description of the side barrier and side pole crash test, including speed and type of crash the test simulates. Consumers can also download technical reports about the vehicle's crash test results. As discussed above, when consumers have accurate information about the effectiveness of crash avoidance technologies, they may be more likely to keep them activated and to experience their safety benefits.

Information on Partial Driving Automation Systems

While NHTSA does not recommend any driver assistance technologies that provide partial driving automation through NCAP, the agency includes some information about partial driving automation systems on its website. For example, on its driver assistance technologies page, NHTSA includes one sentence each to define adaptive cruise control and lane centering assistance, which are components of partial driving automation systems.[52] However, based on our review of NHTSA's website, it does not provide information on that page to give consumers a full understanding of the capabilities, intended use, and limitations of partial driving automation systems.[53]

According to NHTSA's Fiscal Year 2024 budget request to Congress, the agency believes it is paramount to inform consumers of the safety features of new vehicles, along with the potential lifesaving benefits and limitations of these new technologies.[54] In addition, as stated previously, the *Standards for Internal Control in the Federal Government* state that agencies should communicate necessary quality information with external entities to achieve their objectives.[55] In this case, communicating

[52]See National Highway Traffic Safety Administration, "Driver Assistance Technologies," accessed January 5, 2024, https://www.nhtsa.gov/vehicle-safety/driver-assistance-technologies.

[53]A separate NHTSA web page, Automated Vehicles for Safety, discusses automated vehicles more broadly, stating, for example, that currently available systems require the full attention of the driver. See National Highway Traffic Safety Administration, "Automated Vehicles for Safety," accessed January 5, 2024, https://www.nhtsa.gov/vehicle-safety/automated-vehicles-safety.

[54]U.S. Department of Transportation, National Highway Traffic Safety Administration, *Budget Estimates* (Washington, D.C.: Fiscal Year 2024).

[55]GAO-14-704G.

information about the capabilities and limitations of partial driving automation to consumers would help NHTSA achieve its safety goals.

Officials told us that NHTSA could provide more information to consumers about partial driving automation systems, but its efforts with regard to these systems are currently focused on conducting research, investigating defects and initiating recalls, and rulemakings as appropriate. For example, NHTSA supports and conducts research into how human factors may affect the safety of these technologies. NHTSA also examines data from crash reports and consumer complaints for evidence of potential safety problems in particular vehicles.[56] If it finds evidence of a potential problem, it opens an investigation to determine whether a vehicle or vehicle equipment contains a safety-related defect that warrants a recall and remedy. In August 2021, NHTSA began a defect investigation of Tesla's partial driving automation system.[57] In response to NHTSA's concerns about potential driver misuse of its partial driving automation system arising from the investigation, Tesla voluntarily issued a recall of more than 2 million vehicles and deployed over-the-air software remedies in December 2023.

As discussed earlier in this report, drivers' overreliance on partial driving automation systems has been implicated in fatal collisions. With more vehicles in the U.S. equipped with partial driving automation systems each year, there is a growing need to address potential misuse of these systems. As previously noted, we learned from stakeholders and research that consumers' understanding of driver assistance technologies affects how they use them. Given NHTSA's role, NHTSA has opportunities to provide more information to assist consumers' understanding of these technologies.

[56]NHTSA collects crash report data pertaining to partial driving automation systems through a Standing General Order, which it issued in June 2021 and amended in August 2021 and April 2023. The Standing General Order requires vehicle manufacturers to submit reports of certain crashes where their vehicles' partial driving automation systems were engaged at the time of the incident. As of December 15, 2023, 2,321 such incident reports have been submitted to NHTSA, of which 28 reports included fatalities. U.S. Department of Transportation, National Highway Traffic Safety Administration, *Second Amended Standing General Order 2021-01, Incident Reporting for Automated Driving Systems (ADS) and Level 2 Advanced Driver Assistance Systems* (Washington, D.C.: Apr. 5, 2023).

[57]U.S. Department of Transportation, National Highway Traffic Safety Administration, *ODI Resume, Autopilot and First Responder Scenes,* PE 21-020 (June 2022).

Other Educational Efforts

In addition to NCAP and its web page on driver assistance technologies, NHTSA provides information to consumers in other ways, including through public education campaigns and research. For example, in 2021, NHTSA created a media campaign to inform consumers about driver assistance technologies, including forward collision warning, automatic emergency braking, rear automatic braking, blind spot intervention, and lane keeping assistance. As part of this campaign, it produced short informational videos, each with descriptions of different technologies, and purchased advertising space to promote these videos on the internet. Officials told us they are likely to repeat this campaign and may update information about the technologies. NHTSA also conducts and funds research projects, as described above, to support its decision-making on the information it provides about driver assistance technologies.

NHTSA's Roadmap for Updating NCAP Remains in Draft Form After 2 Years, with Time Frames Already Missed

In March 2022, in response to a congressional requirement, NHTSA requested public comments on a draft roadmap that reflects the agency's proposed plans to upgrade NCAP in phases over the next several years.[58] The roadmap includes both near- and long-term proposed actions.[59] In its request, NHTSA stated it would issue a final decision document that would respond to comments and provide appropriate lead time for automakers to plan for changes. Our review of the draft roadmap identified three NHTSA efforts to update NCAP that primarily relate to crash avoidance technologies: (1) recommending four additional crash avoidance technologies in NCAP; (2) revising the mandatory retail sticker that is placed on the window of new vehicles (called the Monroney label);

[58]The Infrastructure Investment and Jobs Act of 2021 directed NHTSA to develop a roadmap covering a period of 10 years, with key milestones for updating NCAP, such as anticipated start, completion, and effective dates of each action. *The Infrastructure Investment and Jobs Act of 2021*, Pub. L. No. 117-58, § 24213, 135 Stat. 429, 827-829 (2021). NHTSA's draft roadmap organized these milestones into four time frames: 2021-2022, 2022-2023, 2023-2024, and 2025-2031. New Car Assessment Program, 87 Fed. Reg. 13,452, 13,503-04 (Mar. 9, 2022).

[59]According to NHTSA, this phased process allows stakeholders to provide data and views on proposed program updates and gives NHTSA the flexibility to make program updates more quickly.

and (3) developing a rating system for crash avoidance technologies.[60] These updates would improve consumer information about crash avoidance technologies, according to several stakeholders we interviewed.

NHTSA describes its plans for these three efforts in its draft roadmap, with time frames for two of those efforts, though the time frames have not been met (see table 1).

Table 1: NHTSA's Proposed Plans for Updating Its New Car Assessment Program (NCAP) for Select Crash Avoidance Technologies

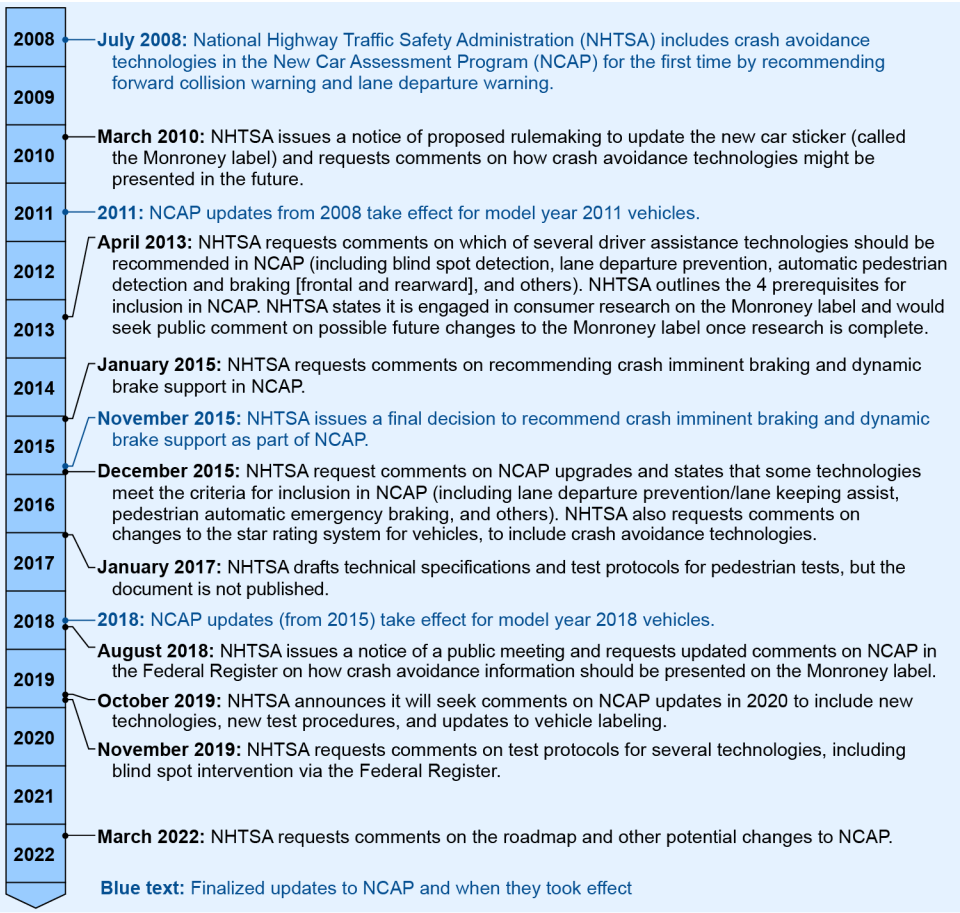
Time frames	Efforts	Description	Status
2021-2022	Adding technologies to NCAP	NHTSA planned to add pedestrian automatic emergency braking, lane keeping support, blind spot warning, and blind spot intervention.	Not complete
2023-2024	Modernizing the new vehicle window sticker (called the Monroney label)	NHTSA indicated ongoing and planned steps to update the window sticker with crash avoidance technologies, including: 1. an ongoing, multi-year consumer research effort, and 2. plans to begin a rulemaking action in 2023.	1. Research remains ongoing 2. Pending completion of research
No time frame identified	Developing a rating system for crash avoidance technologies	NHTSA noted that it will first issue a final decision notice announcing the new crash avoidance rating system, and a final rule to amend the safety rating section of the Monroney label before such a rating would be available to consumers.	Reviewing public comments on the draft roadmap

Sources: GAO presentation of information in the National Highway Traffic Safety Administration's (NHTSA) March 2022 request for comments on its roadmap to update NCAP and NHTSA December 2023 Report to Congress. | GAO-24-106255

While NHTSA has not met some of the time frames set in its draft roadmap, NHTSA has pursued ongoing work related to these three efforts for at least 10 years (see fig. 6).

[60]Also, in its 2022-23 near term actions, NHTSA stated it will consider incorporating additional technologies into NCAP and will announce next steps during this time frame. NHTSA has also proposed increasing the stringency of tests for currently recommended technologies, as described earlier.

Figure 6: NHTSA's Key Actions to Update the New Car Assessment Program with Crash Avoidance Technologies 2008-2022



Source: GAO analysis of National Highway Traffic Safety Administration information. | GAO-24-106255

- **Recommending four additional crash avoidance technologies.** Since 2013, NHTSA has considered recommending additional technologies in NCAP, specifically blind spot warning, lane keeping support, and pedestrian automatic emergency braking (blind spot intervention was not included at that time).[61] In December 2015, NHTSA requested comments on adding these technologies to NCAP and stated that these technologies met NHTSA's four prerequisites for

[61]New Car Assessment Program (NCAP), 78 Fed. Reg. 20,597 (Apr. 5, 2013).

inclusion in NCAP.[62] In November 2019, NHTSA requested comments on test procedures and performance criteria for pedestrian automatic emergency braking, blind spot warning, and blind spot intervention.[63] As part of its March 2022 request for comments, NHTSA asked for comments on updated performance criteria and proposed recommending these technologies in the 2021-22 time frame.

To date, NHTSA has yet to include the four new technologies in NCAP or finalize the performance criteria for testing them. Representatives from several (five of eight) automakers we met with told us that NHTSA needs to update NCAP, as the recommended technologies that are currently included in the program are outdated. According to a representative from one automaker, by recommending new technologies, NHTSA would keep pace with other rating programs such as Euro NCAP and IIHS.

- **Developing a rating system for NHTSA recommended technologies and redesigning the new car sticker.** Starting in 2013, NHTSA has considered developing a rating system that would include crash avoidance technologies and putting that rating on the new car sticker, which Congress required NHTSA to complete by the end of 2016.[64] Since that time, NHTSA has taken a number of steps to revise the rating system and sticker, as well as soliciting stakeholder input through public meetings and comments. However, NHTSA is now 7 years behind both Congress's and its own 2016 deadline. According to NHTSA, it needs to complete steps related to

[62]Those four prerequisites include that: (1) a safety need is known or capable of being estimated based on what is known; (2) vehicle and equipment designs exist (or are anticipated in prototype design) that are capable of mitigating the safety need; (3) a safety benefit is estimated based on the anticipated performance of the existing or prototype design; and (4) a performance-based, objective test procedure exists, or is feasible to develop, to measure the ability of the vehicle technology to mitigate the safety issue. New Car Assessment Program, 80 Fed. Reg. 78,522 (Dec. 16, 2015). In that request for comments, NHTSA stated that 11 crash avoidance technologies met these four prerequisites for inclusion in NCAP. These 11 technologies include, (1) forward collision warning, (2) crash imminent braking, (3) dynamic brake support, (4) lower beam headlighting performance, (5) semi-automatic headlamp beam switching, (6) amber rear turn signal lamps, (7) lane departure warning, (8) rollover resistance, (9) blind spot detection, (10) pedestrian automatic emergency braking, and (11) rear automatic braking.

[63]Advanced Driver Assistance Systems Draft Research Test Procedures, 84 Fed. Reg. 64,405, 64,405-06 (Nov. 21, 2019).

[64]The FAST Act required NHTSA to make information on driver assistance technologies (specifically crash avoidance technologies) available on the vehicle window sticker by the end of 2016. *Fixing America's Surface Transportation Act*, Pub. L. No. 114-94, § 24322, 129 Stat. 1312 (codified at 49 U.S.C. § 32302).

the presentation and approach of the ratings to begin developing the rating system.

Completing this effort can help NHTSA achieve important benefits, including those that align with a key DOT objective. DOT's *National Roadway Safety Strategy* from January 2022 states that for safer vehicles, DOT acknowledges the importance of incentivizing the inclusion of crash avoidance technologies in new vehicles to help reduce the frequency and severity of crashes.[65] In 2015, NHTSA stated that the greatest gains in highway safety in the coming years would result from the widespread use of crash avoidance technologies, and it emphasized the importance of rating these technologies for consumers. According to NHTSA, incorporating crash avoidance technologies into the safety rating would help ensure the technologies are adopted more quickly and in more vehicles. In addition, NHTSA has stated that a rating system for the advanced technologies that are increasingly available in the market would help consumers better understand the technologies' use and safety benefits.[66]

Representatives we interviewed from selected automakers anticipate similar benefits. For example, representatives from one automaker said that including technologies in overall NCAP ratings would do a great deal to improve consumer understanding of driver assistance technologies and would enable consumers to compare various vehicles. Representatives from most (six of eight) automakers told us that they believed, like NHTSA, that it would encourage automakers to improve the technologies and include them in more vehicles.

While the actions described in the roadmap are important steps toward achieving its goals for safer vehicles, as we have reported in 2020 and 2022, NHTSA has repeatedly encountered delays in meeting time frames for various responsibilities, including rulemaking, reports to Congress,

[65]DOT, National Roadway Safety Strategy (Washington, D.C.: January 2022).

[66]New Car Assessment Program, 80 Fed. Reg. 78,522, 78,550 (Dec. 16, 2015).

and progress in updating programs that help fulfill its safety mission.[67] In those reports, we recommended NHTSA follow key project schedule management practices, which include identifying milestones, sequencing activities, and estimating the duration of activities to develop a project schedule.[68] According to the Project Management Institute's (PMI) *Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, these practices can help an agency manage time frames, tailor its efforts to the unique characteristics of each project, and guide programs forward.[69]

During the period since March 2022 when the roadmap has been in draft form, NHTSA has missed some of the time frames it established in the roadmap and has not publicly communicated why progress has been delayed. The statute underlying NCAP, *Standards for Internal Control in the Federal Government*, and the *PMBOK® Guide* all note the importance of external communication.[70] NHTSA received over 4,000 comments on its March 2022 request for comments that included the draft roadmap and other proposals to update NCAP. NHTSA officials further told us that NHTSA is a small regulatory agency with many responsibilities.

When asked when the roadmap would be finalized, NHTSA officials told us they plan to issue a final roadmap as well as recommend four new

[67]The National Roadway Safety Strategy action tracking dashboard on DOT's website indicates that NHTSA has completed the required 10-year roadmap because it issued the request for comments on the roadmap. However, NHTSA has not finalized the roadmap in a final decision in the Federal Register. See GAO, *Traffic Safety: Implementing Leading Practices Could Improve Management of Mandated Rulemakings and Reports*, GAO-22-104635 (Washington, D.C.: Apr. 26, 2022) and *Pedestrian Safety: NHTSA Needs to Decide Whether to Include Pedestrian Safety Tests in Its New Car Assessment Program*, GAO-20-419 (Washington, D.C.: Apr. 23, 2020).

[68]GAO-22-104635 and GAO-20-419.

[69]Project Management Institute, Inc., *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, Sixth Edition, (Newtown Square, Pa.: 2017).

[70]The statute underlying NCAP requires NHTSA to communicate certain vehicle safety information to the public. 49 U.S.C. § 32302(b). *Standards for Internal Control in the Federal Government* state that entities should externally communicate the necessary quality information to achieve their objectives. GAO-14-704G.

technologies in 2024.[71] Given NHTSA has repeatedly missed time frames in the past, including those it sets for itself, it will be important for NHTSA to complete the final roadmap, as it will serve as a guiding document for executing and completing the plans to improve NCAP. Developing time frames that incorporate issue complexity, resource availability, and process requirements as well as publicly communicating when time frames are not met could help NHTSA to make progress on NCAP and better meet its goals. This will enable consumers to make more informed purchasing decisions and encourage manufacturers to improve and deploy more effective and reliable crash avoidance technologies.

Conclusions

Driver assistance technologies—including crash avoidance technologies and driver support systems, such as partial driving automation systems—are increasingly available in new vehicles. Many of these technologies have safety benefits for consumers. However, consumers may not fully understand these technologies, and improper use can compromise their safety benefits and even pose a risk on the road. NHTSA plays a key role in educating consumers about driver assistance technologies. By providing information about how it assesses crash avoidance technologies for recommendation in NCAP, and about the intended use and limitations of partial driving automation systems, NHTSA can help improve consumers' understanding and use of these technologies. Moreover, finalizing and adhering to its roadmap for making needed changes to NCAP—including recommending additional technologies and developing a new system to rate them—would enable NHTSA to provide consumers and manufacturers with more meaningful and timely information, ultimately contributing to safer roadways.

Recommendations for Executive Action

We are making the following five recommendations to NHTSA:

[71]In December 2023, NHTSA submitted a report to Congress on its plan to implement an information and rating system for crash avoidance technologies and vulnerable road user safety technologies. The report was required by the Infrastructure Investment and Jobs Act of 2021, Pub. L. No. 117-58, § 24213(b), 135 Stat. 429, 826-827 (2021). NHTSA's report outlined plans as described in its March 2022 request for comment and stated that it is conducting consumer research to modernize the vehicle safety rating section of the new car window sticker.

The Administrator of NHTSA should communicate to the public on NHTSA's website for vehicle rating information the test conditions and performance criteria NHTSA uses to determine if a vehicle's crash avoidance technologies qualify for a checkmark on the website. (Recommendation 1)

The Administrator of NHTSA should provide more information on NHTSA's public website about partial driving automation systems to clarify the scope of intended use and the driver's responsibility to monitor the system and the driving environment while such a system is engaged. (Recommendation 2)

The Administrator of NHTSA should finalize NHTSA's roadmap for NCAP as soon as possible and include updated and realistic near-term and long-term time frames for changes to NCAP. (Recommendation 3)

The Administrator of NHTSA should communicate progress on meeting time frames established in its roadmap for recommending four additional crash avoidance technologies and provide updated milestones and reasons for delays as needed. (Recommendation 4)

The Administrator of NHTSA should communicate progress on meeting time frames established in its roadmap for developing a system for rating the technologies and redesigning the new car sticker and provide updated milestones and reasons for delays as needed. (Recommendation 5)

Agency Comments

We provided a draft of this report to DOT and FTC for review and comment. In its comments, reproduced in appendix II, DOT concurred with all five of our recommendations and stated it will provide a detailed response to the recommendations within 180 days of the final report's issuance. DOT and FTC provided technical comments, which we incorporated, as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Transportation, the Administrator of NHTSA, and the Chair of the Federal Trade Commission. In addition, the report is available at no charge on the GAO website at https://www.gao.gov.

If you or your staff have any questions about this report, please contact me at (202) 512-2834 or vonaha@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last

page of this report. GAO staff who made key contributions to this report are listed in appendix III.

Andrew Von Ah
Director, Physical Infrastructure Issues

Appendix I: Objectives, Scope, and Methodology

This report (1) provides information on consumers' use and understanding of driver assistance technologies; (2) describes how selected automakers and retailers educate consumers about driver assistance technologies; and (3) assesses the extent to which the National Highway Traffic Administration (NHTSA) contributes to, and could further enhance, consumers' intended use and understanding of these technologies.[1]

Our review includes the crash avoidance technologies that NHTSA currently recommends—forward collision warning, automatic emergency braking (dynamic brake support and crash imminent braking), and lane departure warning—as well as those NHTSA has proposed recommending—pedestrian automatic emergency braking, lane-keeping support, blind spot warning, and blind spot intervention—through its New Car Assessment Program (NCAP). For consistency, we used the NCAP terminology for these technologies whenever possible, although other entities may use different terms. We also examined partial driving automation systems, which, at a minimum, combine adaptive cruise control and lane centering and provided the highest level of automation widely available in U.S. vehicles for sale at the time of our review.

To provide information on consumers' use of these technologies and their understanding of the technologies' safety benefits and limitations, we conducted a literature search for studies on consumer use and understanding of driver assistance technologies. We searched for literature published from January 2017 through December 2022 in database platforms, including ProQuest, EBSCO, Scopus, and Dialog, using a number of search terms, including "consumer understanding" and "vehicle safety tech." We identified an initial selection of 130 academic articles from the literature search. We also conducted general internet searches, asked stakeholders we interviewed to identify relevant studies, and found additional articles cited by relevant literature we reviewed.

[1]The provision directing us to complete this work included a question about how governments are educating consumers about these technologies. We reached out to three safety associations that work with state governments and several state governments about their roles in educating consumers. We reported this information in the background section of our report.

From these sources, we identified a selection of 74 relevant research studies and policy reports.

We found the remaining articles were not relevant to our review for a variety of reasons, including that some articles focused on technologies that we did not include in our scope, or they were not relevant to consumer use or understanding of the technologies. For the relevant studies, we reviewed the studies' design and assessed the methodology to ensure appropriate reporting of results. We summarized the key findings and methodologies for each of the studies and distilled common themes from them.

We also conducted a non-generalizable review of consumer complaints about driver assistance technologies that NHTSA received from 2020 through May 2023, to provide insight into consumer understanding of those technologies. We did not conduct quantitative analysis to determine the extent of consumer understanding or complaints about these technologies. We obtained records of over 260,000 vehicle safety complaints (known as Vehicle Owner Questionnaires) filed with NHTSA from January 1, 2020 to May 16, 2023. We searched complaints using over 800 terms related to driver assistance technologies (e.g., "automatic emergency braking," "automation," and "lane assist") to obtain a list of around 5,000 complaints that could pertain to driver assistance technologies. We reviewed 300 of these complaints, beginning with the first 40 complaints returned in our key word search and thereafter selecting every 20th listed complaint. We added 11 complaints from the end of the list to our review to reach 300 total. We found 70 to be outside the scope of this review and 230 to be within the scope of this review.

Furthermore, we interviewed a non-generalizable selection of stakeholders to obtain their perspectives, including seven automakers, researchers from three academic institutions, and 12 safety, consumer, and industry associations. See table 2 for a list of interviewed stakeholders. The seven automakers we interviewed represented a subgroup of the 10 total automakers we selected based on the largest sales volume in the U.S. and those that included driver assistance technologies within our scope in their vehicle models. In addition to the seven interviewed automakers, one automaker provided responses in writing, and we were unable to coordinate schedules with representatives from two remaining automakers. In addition, we conducted site visits with stakeholders involved in testing and evaluating driver assistance technologies and providing information about them to consumers, to better understand the issues around consumer use and how the

technologies operate. We also interviewed Federal Trade Commission (FTC) officials to obtain an understanding of how FTC collects and analyzes consumer complaints and its role in enforcing truth in advertising laws.

Table 2: Driver Assistance Technologies: Stakeholders Interviewed

State government offices
State of California Department of Motor Vehicles*
State of Nevada Department of Motor Vehicles
Automakers
Ford Motor Company
General Motors
Honda
Mercedes-Benz
Subaru
Tesla, Inc.*
Toyota
Volkswagen Group of America, Inc.
Researchers and others with subject matter expertise
Bryan Reimer, Pnina Gershon, Bruce Mehler, and Chaiwoo Lee, MIT Center for Transportation and Logistics AgeLab
National Transportation Safety Board
Daniel McGehee, University of Iowa Driving Safety Institute
Carol Flannagan, University of Michigan Transportation Research Institute
Consumer, industry, and safety associations
AARP
Alliance for Automotive Innovation
Alliance Highway Safety
American Automobile Association (AAA)
Consumer Reports
Governors Highway Safety Association
Insurance Institute for Highway Safety
MEMA, The Vehicle Suppliers Association
National Automobile Dealers Association
National Safety Council
Partners for Automated Vehicle Education
The American Association of Motor Vehicle Administrators (AAMVA)

* = Submitted written responses in lieu of interview

Source: GAO. | GAO-24-106255

To determine how selected automakers educate consumers about driver assistance technologies, we reviewed websites and vehicle owner's manuals of the 10 selected automakers for information on the technologies within our scope. Specifically, we identified whether the automakers' primary web pages on driver assistance technologies presented information on the capabilities and limitations of the selected technologies. In several instances, automakers use different names for technologies from those used by NHTSA. We used our best judgment to match the automaker's brand names to NHTSA's generic names by comparing the respective names and descriptions of the technologies. We reviewed only the primary web page each selected automaker used to describe its technologies. We did not click through layers of web pages, review vehicle-specific web pages, or review any third-party web pages. We reviewed the same information in vehicle owner's manuals for the same 10 selected automakers, using the manuals of vehicle models selected for the focus of our undercover visits as described below.

To provide non-generalizable, illustrative examples of how retailers educate consumers about driver assistance technologies, we conducted undercover visits to 10 selected retail locations in Maryland and Virginia to inquire about crash avoidance technologies and partial driving automation systems. For each automaker, we selected one vehicle model to inquire about on these visits. We chose vehicle models with a combination of attributes, including body type (sedan or sport utility vehicle), popularity (relatively high sales volume), affordability (cost under $50,000), and those that came equipped with multiple driver assistance technologies within our scope, including partial driving automation systems if possible. We used a directory of retail locations in the Washington, D.C. area to randomly select one retail location for each selected automaker and ensured that each location listed our selected vehicle model as in stock on its website. Our investigator posed as a consumer interested in purchasing a specific vehicle equipped with crash avoidance technologies and, if available in the vehicle model, partial driving automation systems. The investigator asked questions about the selected technologies, including the capabilities and limitations of those technologies.

We recorded and analyzed transcripts of the investigator's interactions with salespeople to determine types of information they provided regarding the specific technologies in our scope. The undercover visits provide illustrative information that is not generalizable to the information about crash avoidance technologies and partial driving automation systems provided by all retailers. We also interviewed selected

automakers, as described above, about the ways in which they provide information on driver assistance technologies to consumers.

To evaluate how NHTSA contributes to consumers' use and understanding of driver assistance technologies, we reviewed NHTSA rulemaking documents and information about driver assistance technologies on the agency's website. We also interviewed NHTSA officials about the agency's current and proposed educational and outreach efforts. We determined that the information and communication component of internal control was significant to this objective, along with the underlying principles that management should externally communicate the necessary quality information to achieve the entity's objectives.[2] We assessed NHTSA's contributions to consumer understanding of driver assistance technologies against the information and communication component of internal control and determined whether those contributions helped NHTSA meet its objectives. We also assessed NHTSA's contributions against its strategic goals and leading project schedule management practices identified by the Project Management Institute (PMI) in *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*.[3]

We conducted this performance audit from September 2022 to March 2024 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives. We conducted our related investigative work in accordance with standards prescribed by the Council of the Inspectors General on Integrity and Efficiency.

[2]GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

[3]U.S. Department of Transportation, *National Roadway Safety Strategy*, Washington, D.C., January 2022; Project Management Institute, Inc., *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, Sixth Edition, (Newtown Square, Pa.: 2017). PMI is a not-for-profit association that provides global standards for, among other things, project and program management. These standards provide guidance on how to manage various aspects of projects, programs, and portfolios.

Appendix II: Comments from the Department of Transportation

U.S. Department of Transportation
Office of the Secretary of Transportation

Assistant Secretary for Administration

1200 New Jersey Avenue, SE
Washington, DC 20590

March 18, 2024

Andrew Von Ah
Director, Physical Infrastructure Issues
U.S. Government Accountability Office (GAO)
441 G Street, NW
Washington DC 20548

Dear Mr. Von Ah:

The National Highway Traffic Safety Administration's (NHTSA) mission is to save lives, prevent injuries, and reduce the economic impacts of crashes occurring on the Nation's roadways. One of the ways in which NHTSA carries out this mission is through education. NHTSA's consumer education efforts through its New Car Assessment Program (NCAP), media campaigns, and website play a vital role in educating consumers about advanced driver assistance systems (ADAS). Notably, NCAP provides comparative information on the safety performance of new vehicles to assist consumers with vehicle purchasing decisions and to encourage safety improvements.

NHTSA is firmly committed to realizing the full safety benefits of ADAS technologies, whether through encouraging adoption of select technologies through NCAP, requiring technologies through rulemaking, investigating potential defects and initiating recalls, conducting educational media campaigns, or conducting research. For example:

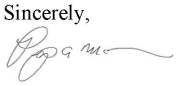
- In 2023, NHTSA issued a notice of proposed rulemaking to require automatic emergency braking (AEB), forward collision warning, and pedestrian AEB on light vehicles.
- In 2023, NHTSA amended its Standing General Order (SGO) on Incident Reporting for Automated Driving Systems (ADS) and Level 2 ADAS. The SGO continues to provide NHTSA with timely information on crashes involving ADS as well as partial driving automation systems, allowing NHTSA to conduct timely investigations into potentially unsafe systems.
- In 2022, NHTSA oversaw 56 recalls for defects related to ADAS.
- In 2022, NHTSA published a notice requesting comment on updating NCAP to recommend an additional four ADAS technologies (blind spot warning, lane keeping support, pedestrian AEB, and blind spot intervention) and update requirements for crash avoidance technologies currently recommended. NHTSA received over 4,000 comments and is moving forward to finalize updates.
- NHTSA provides information about ADAS technologies on its website and has published a set of videos to promote awareness and use of available crash avoidance technologies.

Upon review of the GAO's draft report, NHTSA concurs with GAO's recommendations to (1) communicate to the public on NHTSA's website for vehicle rating information the test conditions and performance criteria NHTSA uses to determine if a vehicle's crash avoidance technologies qualify for a checkmark on the website; (2) provide more information on NHTSA's

public website about partial driving automation systems to clarify the scope of intended use and the driver's responsibility to monitor the system and the driving environment while such a system is engaged; (3) finalize NHTSA's roadmap for NCAP as soon as possible and include updated and realistic near-term and long-term time frames for changes to NCAP; (4) communicate progress on meeting time frames established in its roadmap for recommending four additional crash avoidance technologies and provide updated milestones and reasons for delays as needed; and (5) communicate progress on meeting time frames established in its roadmap for developing a system for rating the technologies and redesigning the new car sticker and provide updated milestones and reasons for delays as needed. We will provide a detailed response to these recommendations within 180 days of the final report's issuance.

We appreciate the opportunity to respond to the GAO draft report. Please contact Gary Middleton, Director of Audit Relations and Program Improvement, at (202) 366-6512 with any questions or if GAO would like to obtain additional information.

Sincerely,



Philip A. McNamara
Assistant Secretary for Administration

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Appendix III: GAO Contact and Staff Acknowledgments

GAO Contact:

Andrew Von Ah, Director, (202) 512-2834 or vonaha@gao.gov

Staff Acknowledgments

In addition to the contact named above, Nancy Lueke (Assistant Director), Danielle Ellingston (Analyst-in-Charge), J. Howard Arp, Laura Bonomini, Sharon Dyer, Michelle Everett, Delwen Jones, Mark MacPherson, Lisa Motley, Joshua Ormond, Samuel Portnow, Patricia Powell, Pamela Snedden, and Elizabeth Wood made significant contributions to this report.

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