Driving Safety Research Institute

An Investigation of the Factors Surrounding Crashes and Near-Crashes of ADAS-Equipped Vehicles

Final Report submitted to the Iowa Department of Transportation and the Colorado Department of Transportation

Author(s):
Michelle Reyes and Cheryl Roe

Date:
April 1, 2025

Driving Safety Research Institute
2401 Oakdale Blvd.
Iowa City, IA 52242

Technical Report Documentation Page

1. Report No. [IDOT to enter]	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle An Investigation of the Factors Surrounding Crashes and Near-Crashes of ADAS-Equipped Vehicles		5. Report Date April 1, 2025 6. Performing Organization Code
7. Author(s) Michelle L. Reyes and Cheryl Roe		8. Performing Organization Report No.
9. Performing Organization Name and Address Driving Safety Research Institute University of Iowa 2401 Oakdale Blvd. Iowa City, IA 52242-5003		10. Work Unit No. (TRAIS) 11. Contract or Grant No. SPR-TPF5(505)-8H-00
12. Sponsoring Agency Name and Address Iowa Department of Transportation, 800 Lincoln Way, Ames, IA 50010 Colorado Department of Transportation, 2829 W. Howard Pl. Denver, CO 80204		13. Type of Report and Period Covered Final Technical Report January 2023-August 2024 14. Sponsoring Agency Code
15. Supplementary Notes Supported by a grant from the U.S. Department of Transportation, Federal Highway Administration		

16. Abstract

This project aimed to investigate the impact of advanced driver assistance systems (ADAS) in real-world crashes and near-crashes. The project considered the perspectives of motorists and law enforcement officers. A survey and interviews gathered information about the motorist's understanding of ADAS and the characteristics of the incident and the vehicle. Motorists reported incidents where ADAS had been beneficial and where ADAS had caused or contributed to the incident. Motorists demonstrated a range of understanding about the ADAS on their vehicles. Some appeared to conflate the functionality of different systems or provided information that contradicted the owner's manual. The officer survey and interview guide asked about their understanding of ADAS, their approach to gathering information about ADAS, crash reporting, and training about ADAS. Very few officers consider ADAS during their crash investigations. Officers cited a lack of training and said considering ADAS was unnecessary because ultimately the driver is still responsible for the crash. Only a few officers who completed the survey had received any training about ADAS. Over 80% of the officers who completed the survey agreed they wanted to receive training about ADAS. Despite the lack of formal or informal ADAS training, many officers rated their level of understanding for various ADAS as high, especially for the three types of collision warnings and adaptive cruise control, and reported the presence of ADAS on a vehicle they drive for work or personal use. The findings from this project inform several recommendations for different stakeholders, including departments of transportation and infrastructure owners/operators, law enforcement, crash reporting agencies, and vehicle manufacturers and dealerships.

17. Key Word Advanced Driver Assistance Systems (ADAS), crash reporting, officer training, consumer education, accident investigation, vehicle technologies	18. Distribution Statement		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Background

Over the last decade or so, more and more new vehicles have been equipped with advanced driver assistance systems (ADAS). These systems can provide warnings, collision avoidance, or sustained driving control assistance. Though numerous published research studies have shown that vehicles equipped with ADAS have lower rates of collision and injury insurance claims, other research has shown that a significant proportion of ADAS owners are unaware or misinformed about their technologies and how they work. Placing too much trust in an ADAS may increase crash risk while a correct understanding may prevent or mitigate crashes. Unfortunately, today's crash reporting systems are not conducive to studying how driver understanding of ADAS affects crashes.

Objectives

This research aimed to investigate the impact of ADAS features in real-world crashes and near-crashes, including consideration of the driver's level of understanding of the vehicle's ADAS feature(s), the crash characteristics such as the environmental and traffic conditions, and whether the feature(s) potentially contributed to or mitigated the crash. The project was composed of two different arms: one focused on motorists and one focused on law enforcement officers.

Approach

For the motorist arm, the team developed a survey and an interview guide to obtain information from motorists operating vehicles likely to be equipped with ADAS features that had been involved in a crash or near-crash incident. The survey and interviews gathered information about the motorist's understanding of ADAS, the characteristics of the incident and the vehicle, and whether the motorist believed the ADAS features impacted the outcome of the incident. The interviews also included questions about the purchase of the vehicle and how the motorist learned about the ADAS on the vehicle.

For the officer arm, a different survey and interview guide were developed to gather information from officers who investigate motor vehicle crashes. These instruments asked the officer about their understanding of the ADAS, their approach to ascertaining the role the ADAS features may have played in contributing to or mitigating the crash, how the officers decide when to include ADAS-related information on the crash report, and training about ADAS.

Motorists and officers were both recruited though emails or letters, social media posts, and postcard handouts. All research methods were reviewed and approved by the University of Iowa Institutional Review Board. Survey responses were summarized with descriptive statistics. Interview transcripts were qualitatively coded to identify themes for each topic discussed.

The surveys and interviews included nine types of ADAS, divided into three categories.

- Collision warnings: blind spot warning, forward collision warning, and lane departure warning
- Collision intervention: automatic emergency braking, automatic emergency steering, and lane keeping assistance

- Driving control assistance: adaptive cruise control, lane centering assistance, and active driving assistance (i.e., simultaneous use of adaptive cruise control and lane centering assistance)

Results: Motorists

A total of 69 motorists completed the survey and ten motorists also completed an interview.

Motorists who completed the survey reported being involved in 42 crashes and 27 near-crashes. Front-to-rear was the most common incident type (35%). The motorists reported whether the vehicle operated during the incident had each of the nine types of ADAS and whether it did anything during the incident. Many vehicles were equipped with the warning type ADAS: blind spot warning (83%), forward collision warning (72%), and lane departure warning (71%). About two-thirds of vehicles had automatic emergency braking (64%) and lane keeping assistance (68%). A large proportion of the vehicles were also equipped with driving control assistance ADAS: adaptive cruise control (85%), lane centering assistance (68%) and active driving assistance (57%). One third of the motorists did not know if the vehicle was equipped with automatic emergency steering.

Survey items asked motorists about their perceptions of driving control assistance ADAS, which are commonly described as convenience features rather than safety systems. A higher proportion of motorists with active driving assistance, which controls both vehicle speed and lane position, said they drive more safely (66%) and are less likely to be involved in crashes (69%) than motorists who were asked about adaptive cruise control (more safely: 33%, less crashes: 39%) and lane centering assistance (more safely: 25%, less crashes: 22%).

Role of ADAS

The researchers conducted ten interviews with motorists and discussed a total of eleven crash and near-crash incidents. The most common type of incident was front-to-rear near-crashes in which forward collision warnings alerted the drivers. In two of these incidents, the vehicle also activated automatic emergency braking, which the participants credited with preventing the collision. In the other two front-to-rear near-crashes, the collision warning may have provided a slight benefit, but the drivers' responses were nearly simultaneous with the warning.

The researchers determined that ADAS likely contributed to two incidents. In one, the participant's vehicle was traveling on the interstate when it activated emergency braking without a visible threat ahead. The vehicle following the participant had to take evasive action to avoid a collision. In the other incident, a driver using active driving assistance (i.e., adaptive cruise control was controlling the vehicle's speed and lane centering was controlling its lane position), described the ADAS failing to detect a lane departure and then the automation "overcorrecting" as the driver fought with the vehicle for control of the steering wheel, before experiencing a road departure and rollover.

Two incidents were related to a loss of control in icy road conditions. Both individuals incorrectly believed that an ADAS on their vehicle could detect and respond to the given situation. The presence of ADAS had no effect in the occurrence of these incidents or the outcomes.

Motorist Understanding and Perceptions of ADAS

The motorist participants had varying levels of understanding about the ADAS on their vehicles. Some motorists had incorrectly identified the ADAS with which their vehicles were equipped. During the interview, many participants did not know what to call their ADAS systems. The interviewees rarely used the manufacturer's names for the ADAS and some participants gave their systems labels that conveyed capabilities the systems did not have. Several motorists conflated the functionality of different ADAS systems or described functionality that contradicted information from the owner's manuals. Multiple participants said that having ADAS made them feel more confident as a driver, while other participants acknowledged that ADAS has affected how they drive, including becoming complacent with checking their blind spot, reducing how often they pass other vehicles, and being less likely to tailgate other vehicles.

ADAS and the Purchasing Experience

Only three motorists said that it had been important to for them to purchase a vehicle with ADAS. Eight of the vehicles were purchased new from a dealership, and the participants described a wide range of dealership experiences. At one end, one participant and their spouse received a customized demonstration drive, and at the other, the dealership staff just listed the ADAS among the vehicle features without providing any information about them. Only two participants got an orientation to their ADAS after the vehicle was delivered to them. Multiple participants said they wished they had learned more about forward collision warning and AEB and lane keep support systems before they had purchased their vehicles.

Results: Officers

A total of 66 officers completed the survey and nine completed an interview.

Nearly all the officers who completed the survey do not consider ADAS as a routine part of their crash investigations. Officers cited a lack of training and awareness about ADAS or not having the training or equipment to download event data recorder (EDR) data from vehicles. Some officers cited probable cause and the need to get data that would "prove" that the ADAS did or did not do something during the crash. Multiple officers were skeptical that asking drivers about the ADAS on the vehicle would yield useful information. Officers also said considering ADAS was unnecessary because ultimately the driver is still responsible for the crash.

Officers who had considered ADAS during an investigation said they had done so because the driver made a statement about ADAS or the officer had noted that the vehicle was relatively new. Fifteen of the surveyed officers indicated they had obtained EDR data to determine ADAS status at the time of the crash. The interviews revealed several challenges officers face when they try to retrieve and interpret EDR data, including expensive equipment and software and a lack of standardization for which ADAS parameters and data sources need to be recorded across different manufacturers.

Collectively the officers identified multiple cases where automatic braking had mitigated crashes as well as several crashes where a vehicle activated AEB and avoided the frontal collision but was struck from behind by another vehicle. Other crashes involved drivers over-relying on blind spot warning and lane assistance features.

Thirty percent of the officers said if they needed to indicate ADAS in the Iowa crash report form they would do so in the Narrative field. Several officers who completed the survey made the point that they do not have the knowledge needed to make a determination about ADAS involvement. Many officers cautioned against making changes to the crash report form until it is easy and efficient for officers to obtain standardized information about ADAS from vehicles and manufacturers.

Only a few officers who completed the survey said they had received any training about ADAS. The majority, if not all, the officers who had learned about ADAS had advanced training in conducting investigations (i.e., technical accident investigation or crash reconstruction). Well over 80% of the officers who completed the survey agreed they wanted to receive training about ADAS and how drivers use them. The officers expressed a preference for receiving training in-person.

Despite the lack of formal or informal ADAS training, many officers rated their level of understanding for various ADAS as high, especially for the three types of collision warnings and adaptive cruise control. These were also the most common ADAS reported by the motorists in this study. Most officers agreed at some level that they knew where on a vehicle to look for ADAS sensors and cameras. Most officers also agreed that they understood the difference between ADAS and automated driving systems. However, at least six of the officers who were interviewed gave responses that indicated that they considered Teslas to be autonomous vehicles.

Recommendations

The findings from this project inform several recommendations for different stakeholders, including departments of transportation and infrastructure owners/operators, law enforcement, crash reporting agencies, and vehicle manufacturers and dealerships. The theme of standardization across different vehicle makes and models was identified for multiple areas during this project. Organizations responsible for designing, implementing, and maintaining infrastructure need to be aware of what information ADAS sensors use and how their operation can be impacted by roadway and environmental conditions. Agencies that are responsible for the registration of motor vehicles should consider enhancing data systems to capture information about the ADAS a vehicle is equipped with when it is first registered. Law enforcement agencies and academies can begin planning ways to provide officers with ADAS training and guidance as to how to consider ADAS during a crash investigation without having to obtain EDR data. Manufacturers can make improvements to ADAS: documentation and data recording, consumer education, and system design.

Conclusions

Advanced Driver Assistance Systems are prevalent in the current fleet of passenger and commercial vehicles. The data collected from this study provides evidence that ADAS can prevent or mitigate crashes as well as contribute to crashes and near-crashes. Motorists and officers have a range of understanding about ADAS. When motorists are unaware of, misunderstand or over-rely on the technologies in their vehicles, their knowledge gaps have the potential to increase crash risk. Improving the quality of information and education given to consumers before, during and after the purchase of their vehicles could be beneficial.

Very few crash investigations consider ADAS or include ADAS information in the report. Most officers who have investigated ADAS have received advanced training in crash investigations. The vast majority of the law enforcement officers who participated in this study indicated a desire to learn more about ADAS to enhance their ability to investigate crashes.

INTRODUCTION

Background

Advanced driver assistance systems (ADAS) are vehicle technology features that are designed to assist drivers by providing warnings, e.g., forward collision warning (FCW), and, in some cases, intervening to avoid an unsafe situation (e.g., automated emergency braking (AEB) and lane keeping assist (LKA). These features are becoming more and more prevalent. NHTSA announced that ten manufacturers installed AEB on all new vehicles from fall 2019 through summer 2020 (NHTSA, 2020). Additionally, more than 90% of all new vehicles are equipped with adaptive cruise control (ACC) and half are able to provide both steering and speed control (Bartlett, 2020).

There is concern that ADAS users may misunderstand or overestimate a system's capabilities, or incorrectly believe that ADAS features enable vehicles to be autonomous or self-driving. Research has shown that some owners of vehicles with ADAS features don't understand what systems their vehicle has (Harms et al., 2020), what their purpose or limitations are (e.g., McDonald, et al., 2018; DeGuzman and Donmez, 2021), and they may choose to disable some of the ADAS features on their vehicles (Reagan & McCartt, 2016). How consumers learn about ADAS technologies can have an impact on their understanding and perceptions of the features (Reyes et al., 2017; Nylen et al., 2019). Branding of ADAS features with system information that emphasized driver convenience rather than driver responsibility led to overconfidence in the system's capabilities (Singer & Jenness, 2020). A high level of understanding and knowledge for ACC resulted in better driver performance in a recent simulator study (Gaspar et al., 2020). An incorrect mental model for or an inappropriate amount of trust in an ADAS feature may contribute to crashes while appropriate models may lead to prevented or mitigated crashes.

While some studies have used police-reported crashes to evaluate the effectiveness of ADAS technologies (Fildes et al., 2015; Cicchino, 2018), there are limitations associated with obtaining the data in this manner. Contrary to conventional understanding, having the vehicle make, model and vehicle identification number (VIN) does not ensure that the technologies available on the vehicle can be identified. Many times, these systems are an option or part of a package that may or may not have been purchased. An officer investigating a crash may interview the driver about what technologies are present on the vehicle and whether they were in use, but this approach can also be problematic if either the driver or the officer is unfamiliar with or doesn't clearly understand the ADAS features. Finally, even when an investigating officer considers whether ADAS are present on the vehicle and may have played a role in the crash, the crash reporting structure does not readily facilitate the inclusion of that information. As a result, there is a dearth of information about the circumstances of crashes involving vehicles with ADAS features and the mental models of the motorists who were operating those vehicles.

Study Objectives

This research aimed to investigate the impact of ADAS features in real-world crashes and near-crashes, including consideration of the driver's level of understanding of the vehicle's ADAS feature(s), the crash characteristics such as the environmental and traffic conditions, and whether the feature(s) potentially contributed to or mitigated the crash.

For the motorist arm, the team developed a survey and an interview guide to obtain information from motorists operating vehicles likely to be equipped with ADAS features that had been involved in a crash or near-crash incident. The survey and interviews gathered information about the motorist's understanding of ADAS, the characteristics of the incident, and whether the motorist believed the ADAS features impacted the outcome of the incident.

For the officer arm, a different survey and interview guide were developed to gather information from officers who investigate motor vehicle crashes. These instruments asked the officer about their understanding of the ADAS, their approach to ascertaining the role the ADAS features may have played in contributing to or mitigating the crash, how the officers decide when to include ADAS-related information on the crash report, and training about ADAS.

The researchers reviewed and coded the interview transcripts and some of the survey responses to identify themes for each arm. The qualitative and descriptive findings inform recommendations for various stakeholders, including departments of transportation and infrastructure owners/operators, vehicle manufacturers and dealerships, law enforcement agencies, and crash reporting agencies.

ADAS Definition/Selection

Today's passenger vehicles offer a variety of ADAS, both as standard and optional equipment. After consulting *Clearing the Confusion: Common Naming for Advanced Driver Assistance Systems* (AAA et al., 2022), the team selected a subset of ADAS to include in the research project. These ADAS warn drivers of potential collisions, provide collision-avoidance (intervention) maneuvers, or provide driving control assistance while the vehicle is in forward motion on a public roadway or street. Systems that provide in-vehicle information (like tire pressure monitoring systems), help with parking (e.g., parking assist) or reversing (e.g., rear cross-traffic alert or rear automatic emergency braking), offer post-collision support (e.g., OnStar), or perform other functions (such as automatic high beams) were not included. The ADAS and their respective acronyms as shown in Table 1 will be used throughout the report.

Table 1. ADAS name, role, acronym and description for ADAS

ADAS Type	**ADAS**	**Description from *Clearing the Confusion* (AAA, et al., 2022)**
Collision Warning	Blind Spot Warning (BSW)	Detects vehicles in the blind spot while driving and notifies the driver to their presence. Some systems provide an additional warning if the driver activates the turn signal.
	Forward Collision Warning (FCW)	Detects a potential collision with a vehicle ahead and alerts the driver. Some systems also provide alerts for pedestrians or other objects.
	Lane Departure Warning (LDW)	Monitors vehicle's position within the driving lane and alerts driver as the vehicle approaches or crosses lane markers.

Collision Intervention	Automatic Emergency Braking (AEB)	Detects potential collisions with a vehicle ahead, provides forward collision warning, and automatically brakes to avoid a collision or lessen the severity of impact. Some systems also detect pedestrians or other objects.
	Automatic Emergency Steering (AES)	Detects potential collisions with a vehicle ahead and automatically steers to avoid or lessen the severity of impact. Some systems also detect pedestrians or other objects.
	Lane Keeping Assistance (LKA)	Provides steering support to assist the driver in keeping the vehicle in the lane. The system reacts only when the vehicle approaches or crosses a lane line or road edge.
Driving Control Assistance	Adaptive Cruise Control (ACC)	Cruise control that also assists with acceleration and/or braking to maintain a driver-selected gap to the vehicle in front. Some systems can come to a stop and continue while others cannot.
	Lane Centering Assistance (LCA)	Provides steering support to assist the driver in continuously maintaining the vehicle at or near the center of the lane.
	Active Driving Assistance (ADA)	Simultaneous use of Lane Centering Assistance and Adaptive Cruise Control features. The driver must constantly supervise this support feature and maintain responsibility for driving.

Technical Advisory Committee

A Technical Advisory Committee (TAC) representing various stakeholder groups from Iowa and Colorado was formed. These individuals included law enforcement officers; technical accident investigators and crash reconstructionists; people who facilitate, perform, and supervise crash data reporting; infrastructure owner/operators; safety planners and data analysts; a former employee of a vehicle manufacturer, and personnel who oversee traffic incident management and emerging and automated transportation technologies. The TAC provided feedback and assistance on the surveys and interview guides, strategies for recruiting participants, obtaining cooperation from law enforcement agencies, and hearing and reviewing the team's findings. The members of the TAC and their affiliations can be found in Table 2.

Table 2. TAC membership

Name	**Affiliation**	**Position/Division**
Matthew Miller	Iowa DOT, concluding project liaison	Director of New and Emerging Transportation Technologies, Systems Operations Division
Heather Pickering-Hilgers	Colorado DOT, concluding project liaison	Assistant Director of Mobility Technology, Office of Innovative Mobility
Andrew Lewis	Iowa DOT, initial project liaison	Director, Traffic Operations Bureau
Sina Zhen	Colorado DOT, initial project liaison	Project Manager, Office of Innovative Mobility
Dennis Kleen	Iowa DOT	FARS, Crashes, & Convictions; Motor Vehicle Division, Records Unit
Josh Halterman	Iowa DOT	TraCS (Traffic and Criminal Software) Program Manager
Larry Grant	Iowa DOT	State Safety Planner, Traffic and Safety Bureau
Michael Messerich	Iowa State Patrol, concluding representative	Sergeant, Technical Accident Investigation Coordinator
Matt Struve	Plymouth County	Deputy Sherriff
Jonathon Wood	Institute for Transportation, Iowa State University (formerly a Data Scientist with Ford Motor Company)	Assistant Professor
Emma Boff	Colorado DOT	Intelligent Transportation Systems & Network Services
Mara Strother	Colorado DOT	Traffic Safety Data Analyst, Safety Performance and Engineering Unit
Alan Scheidt	Colorado DOT	Intelligent Transportation Systems & Network Services
John Ray	Colorado State Patrol	Captain, Criminal Investigations Branch, Vehicle Crimes Unit
Corey Champlin	Iowa State Patrol, initial representative	Lieutenant, District 15 Commander

MOTORIST ARM

This arm collected information from motorists involved in crashes or near-crashes while operating passenger vehicles known or believed to be equipped with one or more of the nine selected ADAS (see Table 1). A literature review was conducted to identify existing relevant survey items or interview questions for gathering information from motorists. A survey was developed to collect data on motorist crashes and near-crashes involving ADAS-equipped vehicles, as well as to identify motorists who would be suitable candidates for an interview. The research team developed an interview guide, which was used during ten motorist interviews. Both descriptive results and qualitative findings from the surveys and interviews are reported.

Literature Scan

The team identified and reviewed scientific literature and web materials to assist in the development of the motorist survey and motorist interview guides. These materials provided insights as to how understanding of ADAS has been captured in previous research, as well as information about which vehicle makes and models were equipped with ADAS features. Key terms, devised by the research team, were used in isolation and in various combinations for the preliminary search in Web of Science. Each search paired one of these key ADAS terms, *ADAS, adaptive cruise control, lane keep* assist,* or *Tesla,* with one of these methodology terms, *survey, questionnaire, or interview*.

Researchers reviewed sixty-one different resources to determine relevance to this study, the type of participant population, the study methodology, the topics included in the study, and the specific language used to ask participants about the given topic. The review studies considered various populations including teens, parents, professional bus drivers, as well as owners of specific vehicles around the world. Among these resources, thirty-seven utilized surveys or questionnaires while twelve utilized interview techniques. Other methodologies included focus groups, case reviews, crash data analysis to estimate market penetrations, and observational studies.

Over one hundred topics of interest were identified. These topics covered knowledge related to ADAS, learning methods and preferences, mental models, trust, reliability, safety, intent to purchase or use, typical use, comfort, expectations, potential benefits, positive and negative aspects, and user recommendations for ADAS design improvements. Additionally, the research explored changes in driving behavior associated with ADAS use over time.

Methods

The motorist data collection consisted of two phases: an online survey and an optional interview. Both methods obtained basic information about the vehicle and the ADAS on it as well as what happened during the incident. The survey also asked the participants about their perceptions and typical use of ADAS. After completing the survey, participants were asked about their interest in participating in an interview. The research team reviewed the survey responses and identified motorists who were suitable candidates for interviews. The topics covered during the interviews included information about the vehicle (year, make, model, ADAS feature(s), etc.) involved in the incident, the participant's understanding and use of the ADAS feature(s) on the vehicle, as well as details about the incident. All research methods for the motorist arm were reviewed and approved by the University of Iowa Institutional Review Board.

Motorist Recruitment

Participants were identified using a variety of recruitment methods. Emails (Appendix A.1. Motorist Recruitment Email) were sent to individuals in the DSRI Subject Registry and to all students, faculty and staff through the University of Iowa Mass Email Service. Social media announcements (Appendix A.2. Motorist Social Media Post) were posted on Facebook and Twitter/X by DSRI and IDOT, as well as through CDOT's social media. Study information was also posted on drivingstudies.com, a webpage hosted by DSRI that informs potential volunteers of current research studies.

Additionally, one recruitment method was directed toward Iowa drivers who had been involved in police-reported crashes. The research team queried the Iowa Crash Data, which did not contain any personally identifiable data and was provided by the University of Iowa Injury Prevention Research Center (IPRC) through an existing Memorandum of Understanding between the university and the Iowa DOT. The query resulted in a list of vehicles driven by potentially eligible drivers, identified by the system-assigned "UNITKEY." The list of UNITKEYs was provided to the Iowa DOT along with 500 sealed, unaddressed envelopes (with postage) containing a letter (Appendix A.3. Iowa DOT Recruitment Letter) and a postcard (Appendix A.4. Motorist Recruitment Postcard). The Iowa DOT used the UNITKEYs to generate address labels for the envelopes and mailed the letters.

Survey

The motorist survey was administered online using REDCap Electronic Data Capture tools hosted at the University of Iowa (Harris et al. 2009) The survey was designed to be completed in about fifteen minutes. The full survey can be found in Appendix B. Motorist Survey. Participants did not receive any compensation for completing the online survey.

A chart in Appendix A.5. Motorist Flow Charts illustrates the flow for the participants in the motorist arm. The survey had two levels of screening to determine participant eligibility. The first level asked respondents to confirm that they were at least 18 years of age and be able to read, write, and understand written English. The second level screened respondents to determine whether they were the operator of a passenger vehicle that was involved in a crash or near-crash incident that occurred on a public roadway or street in the last 12 months. A crash was defined as a collision with another vehicle, departing the road, or striking an object other than an animal. A near-crash was defined as an instance where evasive action was taken to avoid a collision with another vehicle or object (excluding animals) or to prevent a road departure. Diagrams of different incident types were obtained from the *Model Minimum Uniform Crash Criteria (MMUCC) Guideline* (NHTSA, 2017) and included in the survey.

Respondents who indicated they had been involved in an eligible incident were then asked for each of the nine ADAS described in Table 1 to 1) review the system description and 2) indicate whether the vehicle was equipped with that system and if so, what the system did (if anything) during the incident. Respondents who indicated that the vehicle was equipped with at least one of the nine ADAS were permitted to continue with the survey.

Respondents answered questions related to demographics (age, sex, years of driving experience, crash characteristics (incident type, location, road, weather, etc.), vehicle characteristics (year, make, model, ADAS equipped), ADAS understanding and ADAS use. Survey logic was used to restrict questions about individual ADAS to a system present on the vehicle and to prioritize

higher level of driving support or assistance and relevance to the type of incident reported by the participant. For example, a participant would be asked specific questions about blind spot warning only if they indicated that the vehicle had BSW and had been involved in a sideswipe type of incident.

Upon completing the survey, participants who had not been involved in a fatal crash were asked if they would be interested in participating in an interview that would be conducted virtually by phone or video call. Those who indicated interest were screened on the interview eligibility criteria. To be eligible for the interview, participants were required to report that they could speak and understand spoken English, that talking about the incident would not be traumatic for them, and that they could recall details from before and during the incident.

Interview

Selection of Interview Candidates

The researchers reviewed the survey responses of the individuals who were interested in participating in an interview. The primary criterion to evaluate whether the incident would be suitable for an interview was the actual or expected involvement of any of the nine selected ADAS features during the type of incident described by the respondent. For example, the researchers did not select a front-to-front crash involving a vehicle equipped only with BSW, incidents where the respondents struck tires laying in the roadway, crashes where the respondents' vehicles were struck while they were stopped at an intersection, multiple incidents involving the loss of traction in poor road conditions, and road departures where the operators swerved to avoid animals. Researchers also did not select two incidents where the respondents reported they had poor recollection for the incident circumstances and details.

In order to obtain a diverse pool of interview participants, the research team was prepared to consider additional criteria (e.g., participant demographics, vehicle and crash characteristics, variation across the ADAS features involved); however, a reasonable number of candidates was obtained without employing these criteria. The researchers invited all interested participants who had described an incident that did involve or could have involved at least one of the ADAS features reported as present on the vehicle and the respondent had good recollection of the incident.

A researcher emailed each interview candidate inviting them to complete a brief REDCap survey, which asked them to verify they were still interested in participating in an interview, and if they were, to provide additional details about the vehicle in the incident as well as days and times they were available for the interview. Then the researcher emailed the participant with the date and time of the interview appointment along with instructions about how to join the virtual meeting.

Interview Preparation

To prepare for each interview, the researchers used the vehicle identification number (VIN) or the specific vehicle year, model, and trim level to obtain the owner's manual for vehicle the motorist was operating during the incident. The researchers also queried NHTSA's Product Information Catalog and Vehicle Listing (vPIC) VIN decoder and consulted websites for vehicle manufacturers, dealerships, forums, and reviews (e.g., Edmunds, Car and Driver). The

researchers used this information to identify the standard and optional ADAS with which the vehicle was equipped. Then the researchers reviewed the owner's manual content related to each ADAS and summarized it in the first page of the interview guide (see Appendix D. Motorist Interview Guide).

Interview Procedures

The interview appointments were scheduled for 1.5 hours. Upon joining the phone or video call with the participant, a researcher reviewed the informed consent document (Appendix C. Motorist Interview Informed Consent Document) and discussed the interview procedures with the participant. After the researchers answered any questions from the participant, the participant signed the electronic informed consent document in REDCap (Harris et al., 2009). Next the researchers conducted a brief test to verify the recording equipment was working properly. The virtual interviews were conducted, recorded (audio and video) and transcribed via Microsoft Teams. One researcher (CR) conducted the interview with the participant while the other researcher (MR) monitored the interview and the recording equipment and suggested additional follow-up questions for the interviewer to ensure that all the interview topics were adequately covered.

The interview guide can be found in Appendix D. Motorist Interview Guide. The topics covered in the interview included:

- The events leading up to, during and after the incident occurred
- Information about the driving environment at the time of the incident, including infrastructure details, traffic conditions, and weather/visibility conditions
- ADAS system status at the time of the incident
- Their perceptions of whether ADAS usage or non-usage contributed to or potentially mitigated the severity of the incident
- Their understanding of both the functions and limitations of the system(s)
- Their typical usage (or non-usage) of the ADAS features and reasons for using or not using them
- How they learned about the ADAS features on their vehicle (e.g., dealership, promotional literature from OEMs, owner's manual, social media, trial and error).

Transcript Procedures

The researchers prepared the transcripts for coding using a process that consisted of a redaction and verification phase and a cleaning phase.

Immediately after the conclusion of each interview, the researcher who had recorded the interview in Microsoft Teams accessed the transcript file. In the file, the researcher replaced any appearance of the participant's name with "Subject" and the researcher's name with "Researcher." After saving the anonymized file, the researcher exported the updated transcript and the video and audio recordings from Microsoft Teams to the secure study folder on the DSRI data server. The other researcher confirmed the transfer of files to the server had been successful.

The first researcher removed the original files from Teams, and the second researcher confirmed the removal.

In the cleaning phase, one of the team members reviewed the transcript for accuracy against the video recording. The researcher's corrections were tracked as changes in the transcript document. In addition, the researcher removed any references to the proper names of people, businesses, roadways, cities, counties, and law enforcement agencies. The other researcher reviewed and accepted the tracked changes and made additional corrections, if needed. Then one researcher deleted the video recording from the project folder and the other researcher confirmed the file had been deleted. The researchers completed the cleaning phase no more than two weeks after the interview.

Next the transcripts were transformed into Excel spreadsheets. A researcher performed another round of cleaning in the document to merge consecutive phrases from the motorist and the interviewer and ensure that phrases alternated between the interviewer and the participant. Then the transcript was pasted as text into Excel with one row per phrase, each labeled as either the interviewer or the participant. The data were then transformed from the "long" structure to a "wide" structure, with the left column being the paragraph for the interviewer and the right column being subsequent response from the participant. Then columns were inserted to note the interview number and the row number. When all ten interview transcripts had been transformed into Excel, the ten files were appended to create a single spreadsheet for coding.

Qualitative Coding

The researchers created the initial list of codes based on the topics covered by the interview guide. Then additional codes were identified by reviewing two randomly selected interview transcripts and added to the set.

Coding took place in the Excel sheet. First the coding researcher determined whether each exchange between the interviewer and the participant contained information that was relevant to the research objectives. Rows that were not relevant (e.g., introductory questions confirming the type of vehicle) were marked as such and no further coding was done for that row.

The next column indicated whether the topic being discussed concerned a specific ADAS (and if so, which one), the vehicle, or neither of these. In the third and fourth columns, the coding researcher entered codes to describe the questions being asked by the interviewer and the responses from the participants, respectively. As the coding researcher identified new topics in the transcripts, new codes were added to the set. In a third column, the coding researcher wrote a summary of their understanding of the participant's response and also identified initial themes that were relevant to the objectives of the research project.

After the transcripts were coded, the Excel sheet was filtered and searched by code words to ensure that questions that were asked directly from the interview script all used the same codes. Then the interview transactions associated with those code words were examined across participants to identify additional themes. For example, some participants were asked whether they were ever surprised by any of the ADAS on their vehicle. These were coded with the word "surprise" in the column for the questions/prompt codes. The interactions surrounding each mention of the word "surprise" were examined and the codes and research summary of those interview portions were examined to find themes.

Next the list of themes that had been identified were grouped into broader categories. Some categories were associated with specific topics from the interview guide, for example, how the motorists learned about the ADAS features on their vehicle. Others came from across different parts of the interview. For example, the way the motorists described the behavior of their ADAS during the incident, prior to the incident, or how they would describe the system to a family member or friend all yielded responses that could provide information about their level of knowledge and understanding of the systems in question.

Results

This section begins with descriptive statistics for the survey and interview participants and the vehicles they were operating at the time of the incidents. It continues with a summary of the incident characteristics, ADAS equipment on the vehicle, and the perceptions of ADAS reported by the survey participants. Finally, the section concludes with the findings from the qualitative analysis of the interview transcripts.

Motorist Participants

Survey Participants and Vehicles

The survey was accessed 262 times. One person was ineligible for being under 18 years of age. After being presented with information about the study, 146 (56%) provided their consent to complete the survey. A total of 111 completed the first section of the survey, which verified their eligibility. Of these, 28 were excluded because their vehicles were not equipped with ADAS (18), they were not involved in a crash or near-crash (8), or the incident did not occur on public roadway or street (i.e., parking lot, backing out of driveway; 5).

Sixty-nine motorists, 30 males and 29 females, completed the survey. Average completion time for the survey was 12.8 minutes and 75% of respondents completed the survey in less than 15 minutes. Ages ranged from 18 to 78 years and averaged 56 years (median 41 years). Eighty-seven percent identified as white and two-thirds of the participants had obtained a bachelor's degree or higher level of education. Furthermore, 47% reported an annual household income of $80,000 or more. Fifteen participants (22%) reported driving less than 10,000 miles per year, 30 participants (43%) reported driving between 10,000 and 19,999 miles per year, 10 participants (14%) reported driving between 20,000 and 29,999 miles per year, and 12 participants (17%) reported driving more than 30,000 miles annually.

Sixty respondents (87%) identified themselves or a household member as the owner/lessee of the vehicle involved in the incident. The vehicles that were owned by someone else were owned by rental car agencies (3), work (3), a family member or friend (2), and one was not identified. The age range of the vehicles was somewhat uniform, with 23 (33%) being model years 2021-2023, 25 (36%) being model years 2018-2021, and 18 (26%) being model years 2013-2017. Nineteen different vehicle makes were represented, with Toyota (19%), Chevrolet (10%), Ford (10%), and Subaru (10%) being most common.

Interview Participants and Vehicles

A total of 55 individuals expressed interest in participating in the interview. Based on the criteria described above, the research team selected 23 interview candidates. Three of these candidates

responded they were no longer interested, and ten others did not respond to multiple contact attempts.

Ten participants, five males and five females, completed interviews. The interview meetings ranged between 1:06 and 1:30, and the interviews ranged from 0:45 to 1:21. Their ages ranged from 25 to 64 years. Nine participants identified as white, and one identified as Native American or Alaskan Native. Six participants had a bachelor's degree or higher, and eight reported a household income of $80,000 or greater. One participant reported driving less than 10,000 miles per year, 7 participants reported driving between 10,000 and 19,999 miles per year, and 2 participants (14%) reported driving more than 25,000 miles annually.

The vehicle makes represented were Toyota (3), Honda (2), Ford, GMC, Hyundai, Lexus and Subaru. The vehicle model years ranged from 2016 to 2023. All ten participants owned the vehicle involved in the incident. Eight participants reported that they had purchased their vehicle new from a dealership, one from a business that sold used cars, and one in a private party sale.

Recruitment

Table 3 provides a breakdown of which recruitment methods were most useful with identifying respondents, as well as which methods led to the highest percentage of completed responses. Email was the most prevalent recruitment method identified by respondents to start the survey, and it also led to the most completions; however, less than half who started the survey completed it. Although the DOT letter only led to ten people accessing the survey, nine of them completed the survey, and two of those completed an interview. Seven that identified social media were not eligible because they did not have ADAS (4), were not involved in a crash/near-crash (2), or the incident didn't occur on a roadway (1). An additional four didn't respond to any of the ADAS questions and two more responded two three or less.

Table 3. Participants who reported how they learned about the study

	Number of participants	**Percent of participants**	**Number of completed surveys**	**Percent who completed the survey**
Email	114	79%	54	47%
Social media	14	10%	3	21%
DOT letter	10	7%	9	90%
Word of mouth	3	2%	3	100%
DSRI website	1	1%	0	0%
Other	3	2%	1	1%
Total	**144**		**69**	

Descriptive Results

The incidents described by the survey respondents are summarized in this section, along with the ADAS present on the vehicle being operated during the incident, and the respondents' perceptions of the incidents. The last portion of this section provides a description of each incident that was discussed during the interviews with the motorists.

After reviewing the descriptions of the incidents given in the survey and the interviews, the researchers reclassified three incidents reported to be crashes as near-crashes (e.g., respondent described steering to avoid a collision with a vehicle ahead) and one near-crash as a crash (i.e., another car "clipped the rear-end of the car"). The researchers reclassified seven incidents originally classified as "other" types of incidents to the most appropriate category. Finally, the incident type for five of the interview incidents were corrected to the most appropriate type. Four of these were originally described by the respondents as front-to-side but the researchers determined that same direction sideswipe was the most appropriate category.

Incident Characteristics

Seventy-five percent of the incidents occurred in Iowa. Other incidents occurred in Illinois (5), Colorado (3), Minnesota (2), and one each in seven other states. A total of 42 crashes and 27 near-crashes were reported. Table 4 shows the incident types (after corrections) for both crashes and near-crashes. Front-to-rear incidents were the most frequent type for both crashes and near-crashes. Other prevalent crash types were no vehicle involved (e.g., road departures and collisions with objects) and front-to-side. When considering near-crashes, front-to-side and sideswipe-same direction types were more prevalent. Damage to the vehicle was reported by 39 respondents and 19 vehicles were towed after the crash. Twenty-nine respondents reported their crashes had been investigated and reported by law enforcement officers. Six respondents reported they had been cited as being at fault, three had no other vehicle involved, two were front-to-rear, and one was front-to-side. The topic of advanced vehicle technology was only brought up in a crash investigation one time, because a motorist mentioned the feature first, and ADAS was not relevant in the crash scenario. Twelve crashes resulted in at least one injury.

The survey asked the respondents to report the lighting, weather, and roadway conditions present during the incidents, which are reported in Table 5, Table 6, and Table 7. Many incidents occurred during daylight conditions (52), with clear weather conditions (55), and with dry roadway conditions (56). Of the incidents that occurred during daylight conditions, fifty-eight percent resulted in a crash while sixty-seven percent of the dark conditions resulted in a crash. Although the total number of incidents that occurred during weather conditions (fog, rain, snow and other) or with road conditions (wet, ice, snow, frost, slush or gravel) that may influence ADAS functionality was minimal, more were identified as crashes.

Table 4. Incident type for crashes and near-crashes

Incident type	**Crashes** *(n)*	**Near-crashes** *(n)*	**Total** *(n)*	**Percent of total incidents**
No other vehicle involved	11	1	12	17%
Front-to-front	2	2	4	6%
Front-to-rear	13	11	24	35%
Front-to-side	8	6	14	20%
Sideswipe-same direction	5	6	11	16%
Sideswipe-opposite direction	2	1	3	4%
Other	1	0	1	1%
Total	**42**	**27**	**69**	**100%**

Table 5. Lighting conditions at the time of the incident

Lighting conditions	**Crashes** *(n)*	**Near-crashes** *(n)*	**Total** *(n)*	**Percent of total incidents**
Daylight	30	22	52	75%
Dawn	1	1	2	3%
Dusk	2	1	3	4%
Dark, roadway lighted	3	1	4	6%
Dark, roadway not lighted	4	2	6	9%
Dark, roadway lighting unknown	2	0	2	3%
Total	**42**	**27**	**69**	**100%**

Table 6. Weather conditions at the time of the incident (participants could select multiple)

Weather conditions	**Crashes** *(n)*	**Near-crashes** *(n)*	**Total** *(n)*	**Percent of total incidents**
Clear	34	21	55	80%
Cloudy	3	2	5	7%
Fog	1	1	2	3%
Rain	1	0	1	1%
Snow	3	4	7	10%
Other (both include winter weather condition)	2	0	2	3%
Total	**42**	**27**	**69**	**100%**

Table 7. Roadway conditions at the time of the incident

Roadway conditions	**Crashes** *(n)*	**Near-crashes** *(n)*	**Total** *(n)*	**Percent of total incidents**
Dry	34	22	56	81%
Wet	1	1	2	3%
Snow	2	1	3	4%
Ice, Frost	2	2	4	6%
Slush	1	0	1	1%
Gravel	2	0	2	3%
Unknown	0	1	1	1%
Total	**42**	**27**	**69**	**100%**

Sixty-one respondents reported knowing the speed limit of the road where the incident occurred. The limits identified ranged from 15 to 70 mph, as shown in Table 7. The most common speed limit was 55 mph followed by 35 mph.

Table 8. Speed limit at the time of the incident

Speed limit (mph)	**Crashes** *(n)*	**Near-crashes** *(n)*	**Total** *(n)*	**Percent of total incidents**
70	1	7	8	12%
65	4	4	8	12%
60	0	1	1	1%
55	15	3	18	26%
50	1	0	1	1%
45	2	1	3	4%
40	1	0	1	1%
35	9	4	13	19%
30	1	2	3	4%
25	3	0	3	4%
20	0	1	1	1%
15	0	1	1	1%
Unknown or prefer not to answer	5	3	8	12%
Total	**42**	**27**	**69**	**100%**

The survey presented participants with a list of roadway features. Features that were most often present included more than one lane of travel in each direction (55%), speed limit above 55 mph (49%), lanes divided by a median or other barrier (28%), and shoulder line rumble strips (22%). (Note: some respondents gave responses related to the speed limit in the roadway features that was inconsistent with the specific speed limit they had reported. For example, some respondents who reported the speed limit was 55 mph also indicated “speed limit above 55 mph.”)

Table 9. Roadway features present at location of the incident (participant could select multiple)

Roadway features	**Crashes** *(n)*	**Near-crashes** *(n)*	**Total** *(n)*	**Percent of total incidents**
Speed limit above 55 mph	16	18	34	49%
Speed limit below 35 mph	9	6	15	22%
More than one lane of travel in each direction	21	17	38	55%
Lanes divided by median or other barrier	5	14	19	28%
Exit or entry ramp	5	5	10	14%
Overpass or underpass	2	3	5	7%
One-way street	2	1	3	4%
On-street parking	1	0	1	1%
Faded or missing lines	1	2	3	4%
Center line rumble Strips	2	1	3	4%
Shoulder line rumble strips	6	9	15	22%
Work zone or road construction	3	0	3	4%
Pedestrian crosswalk	2	1	3	4%
Bicycle lane	0	2	2	3%
Hill	7	3	10	14%
Curve	2	5	7	10%
Bridge, railroad crossing, variable speed limit corridor, or dynamic message sign	0	0	0	-
Other	3	1	4	6%
Total	**42**	**27**	**69**	**100%**

ADAS Equipment Reported

All 69 respondents identified which of the nine ADAS in Table 1 were equipped on their vehicle, whether the ADAS was active at the time of the incident, and whether the system may have intervened or provided a warning. The responses for each ADAS type (i.e., driving control, intervention, and warning) can be found in Table 10, Table 11, and Table 12. Respondents most often reported the vehicles as equipped with adaptive cruise control followed by the three ADAS that provide warnings (blind spot warning, forward collision warning, and lane departure warning). Not surprisingly, AES was the least prevalent.

Table 10. Vehicles equipped with driving control type ADAS

ADAS	The vehicle had this system and…			The vehicle did not have this system.	I don't know if the vehicle had this system.	Total equipped *n* (%)
	I am confident it was active at the time of the incident.	I am not sure if it was active at the time of the incident.	I am confident it was not active at the time of the incident.			
ACC	21	7	31	9	1	59 (85%)
LCA	26	5	16	20	2	47 (68%)
ADA	19	3	17	21	9	39 (57%)

There seems to be uncertainty about respondents' understanding when ADAS provide intervention. Forty-one percent of respondents who said the vehicle was equipped with automatic emergency steering (i.e., 7 out of 17) were unsure if it intervened at the time of the incident. Of those with automatic emergency braking, 30% were not sure if it had intervened. Among the 47 respondents whose vehicles had lane keeping assist, 28%were unsure about LKA providing intervention.

Almost one quarter of the respondents with BSW were unsure if it provided a warning. Twenty percent were unsure if FCW provided a warning, and sixteen percent were unsure about LDW.

Since vehicles can be equipped with warning but disabled, additional questions about whether the ADAS was enabled at the time of the incident. Six disabled LDW and one disabled FCW. Two were uncertain about whether LDW was enabled, and one was uncertain about whether BSW was enabled.

Table 11. Vehicles equipped with intervention type ADAS

ADAS	The vehicle had this system and…			The vehicle did not have this system.	I don't know if the vehicle had this system.	Total equipped *n* (%)
	I am confident it intervened during the incident.	I am not sure if it intervened during the incident.	I am confident it did not intervene during the incident			
AES	1	7	9	30	22	17 (25%)
AEB	16	13	15	15	10	44 (64%)
LKA	15	13	19	16	6	47 (68%)

Table 12. Vehicles equipped with warning type ADAS

ADAS	The vehicle had this system…					The vehicle did not have this system	I don't know if the vehicle had this system	Total equipped *n* (%)
	and I am confident it issued a warning during the incident	enabled at the time of the incident but I am not sure if it issued a warning	enabled at the time of the incident and I am confident it did not issue a warning	but I'm not sure if it was enabled at the time of the incident	but it was disabled at the time of the incident			
BSW	20	14	22	1	0	10	2	57 (83%)
FCW	24	10	15	0	1	13	6	50 (72%)
LDW	18	8	15	2	6	15	5	49 (71%)

Perceptions of ADAS

As shown in Table 13, almost all respondents had some level of agreement with statements that asked about their understanding about the limitations of ADA and ACC as well as the conditions necessary for ADA and ACC to work effectively. Eighty-four percent of the respondents agreed they could explain ACC to others, compared to 63% for ADA and 44% for LCA.

Table 13. Motorists' ratings for statements about ADAS understanding

Statement	*(n)*	Strongly disagree	Disagree	Neutral	Slightly Agree	Agree	Strongly agree
I understand which conditions (including environments and roadways) are necessary for **ADA** to work effectively.	32	0	1	2	0	13	16
I understand the limitations of **ADA**.	32	0	1	0	0	17	14
I can explain **ADA** and its behavior in different situations to others.	32	0	3	9	0	10	10
I understand which conditions (including environments and roadways) are necessary for **ACC** to work effectively.	19	2	0	0	2	5	10
I understand the limitations of **ACC**.	19	2	0	0	0	6	11
I can explain **ACC** and its behavior in different situations to others.	19	2	0	0	4	4	8
I understand which conditions (including environments and roadways) are necessary for **LCA** to work effectively.	9	1	1	2	0	3	2
I understand the limitations of **LCA**.	9	2	1	0	0	4	2
I can explain **LCA** and its behavior in different situations to others.	9	2	2	1	0	2	2

ADA is widely considered to be for driver convenience rather than a safety. However, as shown in Table 14, twenty-one respondents believe that they drive more safely and twenty-two believe that they are less likely to be in a crash. Seven respondents said ADA causes them to pay less attention while ten respondents say they pay more attention. Stress levels and boredom remained about the same or decreased while the level of enjoyment remained about the same or increased. In comparison, those who responded to the ACC and LCA statements were more likely to report no difference when it came to driving safely and likelihood of being in a crash.

Incidents Discussed during Interviews

This section describes the eleven specific incidents the researchers and the participants discussed during the interviews, including the participants' perceptions of the ADAS involvement.

Incident #1: Near-Crash with Forward Collison Warning on City Street

The participant was driving in "a lot of traffic" on a city street with two lanes in each direction divided by a curbed median. The speed limit was 35 mph and the participant was driving in the left lane with an estimated speed of 35-40 mph. A vehicle in lane to the right of the participant moved left entering the lane in front of the participant, leaving "maybe one car length" of space between the two vehicles, and then the driver of the other vehicle slammed on the brakes to make a U-turn. "Kind of simultaneously," the participant noticed that the vehicle ahead was braking and the participant's vehicle began "beeping" and "flashing on the instrument panel." The participant "stomped" on the brake pedal. The participant's vehicle came to a complete stop "within inches" of making contact with the other vehicle.

The participant believes the warning might have helped avoid the collision. "It was a split second of it alerting me and me noticing that the vehicle was slowing down quickly in front of me, to the point where it's tough to say which happened first." The participant is not sure whether the vehicle provided any braking assistance. The participant and their spouse had owned the vehicle for more than three years when the incident occurred.

Incident #2: Near-Crash on Icy Roadway

The participant was driving uphill on a two-lane street. Their speed was between 25 and 30 mph and the roadway was icy. A large pickup coming down the hill from the opposite direction was "going way too fast." The pickup lost control on the ice and crossed the center line. The participant was able to brake and the pickup slid across the participant's lane of travel "probably no more than a foot" from the front bumper of the participant's vehicle. The pickup then went over the curb to the participant's right and came to rest off the street. The pickup driver was not injured and was able to drive the vehicle back onto the roadway. The participant described disappointment that the vehicle had not issued a collision warning during the incident. "It has worked in the past, when I'm driving behind someone… and I get a little bit too close, or somebody in front of me stops very quickly, but nothing came on when he came over and came in front of me… I don't know why, but the system was on." The participant had owned the vehicle for a nearly three years when the incident occurred.

Table 14. Perceptions of how ADAS influences driving.

Consider how your driving with [ADAS] compares to driving without any advanced technologies. With [ADAS]…							
ADAS	**Statement**	**(*n*)**	**Much less**	**Less**	**No difference**	**More**	**Much More**
ADA	I drive __ safely.	32	0	1	9	14	7
ADA	I am __ likely to be involved in a crash.	32	8	14	7	1	2
ADA	I pay __ attention to driving.	32	0	7	15	8	2
ADA	Driving is __ stressful.	32	4	14	10	3	1
ADA	Driving is __ boring.	32	1	2	23	5	1
ADA	Driving is __ enjoyable.	32	1	4	12	11	4
ACC	I drive __ safely.	18	0	1	11	3	3
ACC	I am __ likely to be involved in a crash.	18	2	5	10	1	0
ACC	I pay __ attention to driving.	18	0	6	7	2	3
ACC	Driving is __ stressful.	18	1	11	5	1	0
ACC	Driving is __ boring.	18	2	3	10	1	2
ACC	Driving is __ enjoyable.	18	1	3	6	5	3
LCA	I drive __ safely.	8	0	1	6	2	0
LCA	I am __ likely to be involved in a crash.	9	0	2	7	0	0
LCA	I pay __ attention to driving.	9	0	3	3	3	0
LCA	Driving is __ stressful.	9	0	2	5	2	0
LCA	Driving is __ boring.	9	0	0	7	2	0
LCA	Driving is __ enjoyable.	9	0	0	6	3	0

Incident #3: Near-Crash after Braking Activation on Highway

The participant was driving in the right lane of a two-lane interstate highway where the speed limit was 70 mph. The participant was using active driver assistance (i.e., adaptive cruise control and lane centering assist together) and estimated their speed to be between 70 and 78 mph. Ahead, also in the right lane but still outside the radar range, was a semi. The participant checked the rearview mirror and saw a pickup truck in the left lane "a ways behind." The participant signaled left and moved the vehicle into the left lane to pass the semi. When the front of the participant's vehicle was "almost kind of level" with the back end of the semi, the participant's vehicle "slammed on the brakes" "full force," but the vehicle did not come to a complete stop. The pickup truck traveling behind the participant swerved to the left shoulder area, and the participant swerved their vehicle back into the right lane. The participant said, "I'm not certain which system it was that slammed on the brakes," but they believe the ADAS on the vehicle caused the incident. The participant took the vehicle to dealership for service after the incident, but the technicians were not able to identify why the vehicle's brakes would have been activated. The participant had owned the vehicle for approximately six years when the incident occurred.

Incident #4: Road Departure with Active Driving Assistance

The participant was driving approximately 60 mph on a two-lane road with a speed limit of 55 mph. The participant was driving with "lane assistance" and "cruise control" active and no other traffic was present. The participant "looked down" at the radio and when they looked back to the road, they noticed that the car "was kind of hugging" the paint line on the outside of the lane. The participant does not recall the "lane detection" issuing any warning. The participant tried to steer the vehicle "away from the ditch and it over corrected." They stated, "It was making me swerve back and forth" between the lanes. The vehicle departed the roadway to the left and rolled several times, coming to rest upright off the roadway. The emergency notification feature on the vehicle connected to an operator, who spoke with the participant and the operator notified local EMS. The participant was able to self-extricate from the vehicle. When EMS arrived, the participant reported having neck pain and was transported to the hospital. A crash report was conducted. The participant told the officer that "my vehicle over-corrected and was making me swerve in and out of both lanes," and believes they told the officer about the lane assistance. The participant did not recall the officer asking any questions or commenting about the ADAS. The participant had owned the vehicle for approximately three months when the incident occurred.

Incident #5: Near-Crash with Automatic Emergency Braking on Highway

The participant was driving their spouse's vehicle on an interstate highway in an urban area with four or five lanes in the same direction. There was heavy traffic flowing very quickly and smoothly in all lanes. The participant was traveling around 80 mph in the left lane and was about three car lengths behind the vehicle ahead of them. Then they noticed brake lights on vehicles in multiple lanes "two or three" vehicles ahead of the vehicle they were following. The participant began "tapping" their brakes and "all of a sudden, the car slammed its brakes on, faster than I was doing it, and came to a dead stop, because the cars in front of me did also." The participant's vehicle stopped about one foot behind the vehicle ahead. The vehicle traveling behind the participant went onto the shoulder. The participant stated that the automatic braking "probably stopped me from having to go into the breakdown lane or hitting the car in front of me." The participant had a different primary vehicle and estimated they drove their spouse's vehicle, which they had owned for 2-3 years, twice a month.

Incident #6: Sideswipe Collision while Turning Right

The participant was stopped at a stop sign in the right lane of two lanes that both turn right onto an interstate on-ramp. There was a pickup in the left lane also stopped at the stop sign. Both vehicles proceeded from the stop sign to turn right onto the ramp, and the participant took the turn too wide. The front driver side panel and side mirror of the participant's vehicle made contact with the wheel well area on the front passenger side of the pickup. The participant reported they heard a "beeping warning" when they "got too close to the vehicle." The participant attributed this warning to the sensors that are activated when the vehicle "is in too close proximity to another vehicle or inanimate object." The participant did not notice a visual indication in the mirror from the blind spot warning and reported they would have expected that to be present in this situation. The participant was thinking about a stressful family situation and admitted to being distracted. The participant did not have the awareness, time, or both to react to the proximity warning they heard and also stated that an indication from the blind spot warning would not have changed the outcome. The participant had co-owned the vehicle with their spouse for more than two years when the incident occurred.

Incident #7: Sideswipe Collision while Changing Lanes

The participant was driving on a city street with two lanes in each direction and a speed limit of 35 mph. The vehicle was traveling around 30-35 mph in the left lane, and the driver decided to change lanes. The driver looked in their mirrors for traffic and noted a vehicle "back far" in the right lane. The driver activated their turn signal and when about one quarter of their vehicle was over the lane line, the car in the right lane struck the participant's front passenger door and fender. The participant said they did not get an alert to a car in their blind spot, "which was weird." The participant believed they should have gotten a warning from the blind spot warning, and that if they had, they would have been able to avoid the collision. The participant had owned the vehicle for approximately three years when the incident occurred.

Incident #8: Near-Crash with Automatic Emergency Braking on City Street

The participant was driving at an estimated speed of 30 mph on a street in a business area with two lanes in each direction divided by a center turn lane. All lanes of traffic "were flowing just fine." The participant was driving in the left lane "maybe a car length" behind another vehicle, which "stopped abruptly" for an unknown reason. The participant saw the brake lights but "had no time to hit the brakes." "Essentially all at the same time," there was a beeping noise, a red light flashed on the dash, and the vehicle braked on its own with a lot of force. The participant also put their foot on the brake pedal. The participant's vehicle stopped about two feet behind the vehicle ahead. The participant also shared, "The vehicle very much responded quicker than I reacted…It definitely stopped me from hitting the vehicle in front of me." The participant had owned the vehicle for two years when the incident occurred.

Incident #9: Near-Crash with Forward Collision Warning on Interstate

The participant was driving on an interstate highway with two lanes in each direction. The participant was traveling approximately 75 mph in the left lane with their spouse in the front passenger seat and two friends in the back seat. There was a "fair amount of traffic" that was "moving along well." As the participant's vehicle approached the crest of a hill, their spouse told the driver the vehicles ahead were slowing down. The participant noticed "everyone was slamming on their brakes." The participant began braking hard "about the same time" as the

collision avoidance displayed a red visual indicator and an auditory signal. The participant looked in the rearview mirror to check the traffic behind the vehicle and could tell the person behind them was not going to be able to stop in time. The participant moved to the left and went partly onto the shoulder. The participant vehicle stopped about 3 feet from the car in front of it, which came to a stop and stayed in its lane. The vehicle from behind moved to the right and split the two lanes, coming to a stop with its front bumper even with the participant vehicle's rear wheels. Another vehicle from further behind ended up driving into the median and came to a stop in the median ahead of the participant vehicle. The participant is not sure whether their vehicle provided additional braking. "I think it helped. If my [spouse] hadn't said anything, it might have gone off and that would have been my first indication." The participant had owned the vehicle for nearly four years when the incident occurred.

Incident #10: Sideswipe on Icy Roadway

The participant was traveling 52 mph on an urban interstate in the second lane from the left with four lanes going in the same direction. The road was icy and there was a lot of fog. The participant noticed a vehicle was present in the lane to their left, slightly behind and just visible in the participant's peripheral vision. However, the participant reported that the blind spot warning did not go "off." After about two seconds, when the other car was "in line with" the driver side door, the other car "just disappeared." The participant said, "I felt like I just got hit a little in the back," and then the participant's vehicle started losing control. The other vehicle also lost control. Both vehicles spun around several times as they left the roadway and entered the right-side ditch. The other vehicle entered the ditch first, and the participant vehicle struck it front-to-front. Both drivers were transported by ambulances. The weather and road conditions were noted as contributing to the crash, and each driver's own insurance covered their own damages. The participant is certain that not getting a warning from the blind spot warning affected the outcome of the incident. "I honestly think that if [BSW] had warned me… I could have gotten out of the way." The participant had owned the vehicle for a few months when the incident occurred.

Incident #11: Near-Crash in a Roundabout

The participant was preparing to enter a single-lane roundabout and was looking at a truck that was already in the roundabout. As the participant's vehicle was "maybe halfway" into the roundabout, the blind spot warning light in the driver side mirror came on and the proximity (parking) sensors made a beeping sound. The participant braked and steered to the right to avoid a car approaching from the left, while the car veered left onto the skirt of the roundabout. The car proceeded ahead of the participant and both vehicles exited the roundabout. The participant said, "I absolutely should have been paying more attention and looking to my left, getting on that roundabout." The participant also said, "I like to think that I eventually would have seen that car, but… I'm just happy I had [the warning]." The participant had owned the vehicle for about two years when the incident occurred.

Qualitative Results

This section describes the qualitative results of the motorist arm, including the researchers' assessment of the role of ADAS during the incident, themes related to the motorists' understanding and perceptions of ADAS, their purchase experiences, learning experiences, and feedback about ADAS design.

Role of ADAS in Crashes and Near-Crashes

This section summarizes the researchers' assessment about the role ADAS played in the crashes and near-crashes described by the motorists who were interviewed. There were incidents where the ADAS likely helped prevent a collision, where the ADAS likely contributed to the incident, where the role of ADAS could not be determined, and where the presence of ADAS had no effect.

Half the participants who were interviewed felt the ADAS in their vehicle had a positive effect on their incident. Two fully credited AEB with preventing a front-to-rear collision (Incidents #5 and #8) and two more believed their FCW or FCW/AEB may have helped avoid a front-to-rear crash (Incidents #1 and #9). Finally, the activation of BSW and proximity sensors may have helped avoid a sideswipe crash in a roundabout (Incident #11).

There were two incidents in which the use of ADAS contributed to the situation. In Incident #3, a six-year-old vehicle activated automatic emergency braking on the interstate when there was no threat ahead, causing a near-crash that could have been catastrophic. In Incident #4, a driver using active driving assistance (i.e., adaptive cruise control and lane centering were active), described the ADAS failing to detect a lane departure and then the automation "overcorrecting" as the driver fought with the vehicle for control of the steering wheel before experiencing a road departure with rollover. While the researchers cannot say with certainty that the ADAS in these vehicles malfunctioned, the incidents would not have occurred if the vehicles had not provided braking and steering, respectively.

Two participants were involved in minor sideswipe crashes (#6 and #7) in which the participant's vehicle was the one to leave the original lane of travel. Both participants said they did not see a blind spot warning indicator in their side mirror and both believed the vehicle should have shown one. However, they also provided descriptions of their BSW systems that did not correspond to the information provided in their owner's manuals, so the role of ADAS in these crashes is unclear. The driver in Incident #6 said they heard an audio alert that they believed indicated that something was in close proximity, but they were unable to react in time to avoid a collision.

Two participants were involved in incidents (#2 and #10) related to a loss of control in icy road conditions. Both individuals incorrectly believed that an ADAS on their vehicle could detect and respond to the given situation. The presence of ADAS had no effect in the occurrence of the incidents or the outcomes.

Motorist Understanding and Perceptions of ADAS

While reviewing the interview transcripts, researchers identified a number of themes related to the motorists' understanding of their ADAS.

Knowledge of ADAS Equipment on the Vehicle

Considering their initial survey responses, the ten interview participants demonstrated a range of knowledge about the ADAS on the vehicle involved in the incident. Four participants accurately reported whether or not the vehicle had each of the nine ADAS included in the survey. Two participants gave just one incorrect response, and both were incorrect about whether their vehicle was equipped with automatic emergency steering. One of these reported the vehicle had AES when nothing in the owner's manual referred to this capability. The other participant reported

that the vehicle was not equipped with AES when the owner's manual and other resources reported that functionality was standard equipment for the vehicle's trim level. Two other participants reported that their vehicles were equipped with lane centering assist and active driving assist when they were not.

The last two interview participants demonstrated a poor understanding of what ADAS were on the vehicle involved in the incident. One participant, who was driving their spouse's vehicle during the incident, incorrectly reported that the vehicle was not equipped with lane centering assistance, active driving assistance, or lane departure warning. The other participant, who no longer owned the vehicle involved in the incident, reported in their survey responses that it was equipped with all nine ADAS features when the vehicle was only equipped with the three collision warning systems and none of the collision intervention or driving control assistance systems. The lack of regular or recent experience with the vehicle that had been involved in the collision may have potentially contributed to these two participants' not knowing what ADAS were on the vehicles.

Across the different ADAS, the interview participants were most often unsure or did not know whether the vehicle was equipped with automatic emergency steering, with only 4 participants correctly indicating the presence or absence of that system.

Names for ADAS

When the researcher asked motorists to describe the ADAS in their vehicle, numerous participants responded with some variant of, "I don't know what to call it. I just know a little bit about what it does." Those who did provide system names while describing the ADAS on their vehicles rarely used the generic ADAS name and never used the official name from the manufacturer.

While some participants used the term "adaptive cruise control" and one used "radar cruise control," more simply called it "cruise control," even though they were clearly describing the enhanced functionality of ACC and not conventional cruise control. One participant referred to ACC as both the "auto-speed thing" and "autopilot."

No participants used the term "forward collision warning" and only one referred to their "automatic braking system." Rather, three motorists called these systems "collision avoidance," and others used names like, "collision alert," "collision indicator," "crash monitoring," "pre-collision," and "brake assist."

Two participants named blind spot warning, and one participant called it "passer assist."

A few participants used the terms "lane departure warning" and "lane keep assist." Others used the names "lane correct," "lane detection," "lane assistance," and "lane guidance." Several participants conflated lane-related warnings and interventions. Some described the *warning* functionality of LDW while using a name that indicated that the system would *intervene* with steering assistance. Others did the opposite and described the assistance functionality of LKA as a system named "lane departure warning."

Misunderstanding of Active Driving Assistance

Clearing the Confusion describes Active Driving Assistance as the "Simultaneous use of Lane Centering Assistance and Adaptive Cruise Control features." The motorist survey included this

description immediately above the responses that allowed the respondents to indicate the presence (or absence) and use of the system during the incident. However, seven survey respondents who indicated that their vehicle was equipped with both ACC and LCA also said their vehicle did not have ADA (n = 2) or they did not know if their vehicle had ADA (n = 5). Additionally, two who indicated that ADA was active during the incident indicated that ACC was not active, one was unsure if ACC was active, and another person was unsure if LCA was active. These results indicate misunderstanding of ADA since it requires ACC and LCA.

One motorist interviewee said they thought the generic name "active driving assistance" referred to the collection of driver assist features on their vehicle: "Maybe I'm misunderstanding it, but I think the active driving assist is the system that helps you avoid collision." The manufacturer of the vehicle operated by this participant had grouped and marketed numerous safety and convenience systems under an umbrella term, which may have contributed to their misunderstanding. Another survey respondent said reported that ADA was active in a crash when another vehicle "backed into my car while I was backing out of a parking space." The motorist continued, "brake notification appeared on the dashed and applied and alarms went off." That situation does not match the operating conditions or the functionality for ADA.

Conflating Functions from Different ADAS

During the interviews, multiple motorists seemed to conflate features from different ADAS as they described them. When prompted to describe any systems on the vehicle "related to the lanes," one participant said that a light flashing on either of the side rearview mirrors indicated that "you're getting too close to whatever's on that side, and you need to move over." This description seems to conflate the visual display for the blind spot warning in the mirror with some of the functionality of lane departure warning or lane keeping assistance.

The same participant said that "the car will tell you if you're getting too close to another vehicle in front of you" by beginning to slow down. This description may correspond to the functionality of ACC, but the participant also said this system was "on all the time." This particular vehicle had three different timing settings for the FCW system, which the participant might have confused with the three gap settings for the ACC. Another participant gave a similar response when describing a feature in their vehicle which visually indicated on the instrument panel the time gap to the vehicle ahead. The manual for their vehicle stated that this following distance display would not appear when the adaptive cruise control was active, but the participant reported that the feature worked when ACC was active. This may indicate that the participant believed the gap settings for the ACC corresponded to the levels shown in the following distance display, a belief that would be incorrect given the information provided for each of these systems in their owner's manual.

A third participant, while describing ACC, stated, "if you get closer to the vehicle [ahead], [ACC] will, like, warn you." When prompted to describe how their vehicle warned them, the participant said it would "flash an alarm" "on the dashboard" and "automatically brake." This description reflects the functionality of the FCW and AEB. The participant who experienced an unexpected braking activation while driving on the interstate (Incident #3) said, "I'm not certain which system it was that slammed on the brakes. Was it the collision avoidance or the adaptive cruise? Because either one can." This statement is probably not accurate, as the level of brake activation described by the participant corresponds with AEB and would almost certainly be beyond the capabilities of the ACC.

When asked how they would describe the FCW and AEB to a family member or friend, the participant who had been driving their spouse's vehicle at the time of their incident included the functionality of the ACC in their description. "It slows your car down for you and you don't realize it. And all of a sudden, you're going 40 miles an hour behind [another vehicle]."

Finally, one participant made this comment with respect to AEB, "There was one time I was parking, and I took my foot off the brake before I had put it into park. So, it rolled forward a bit, and then it actually stopped the vehicle before it hit the pole in front of me. So it works." The functionality described by the participant is designed to assist a driver while they are parking and is different from the AEB that would activate while a vehicle is traveling above a certain speed and is approaching a slowed or stopped vehicle ahead.

Motorist Misunderstandings

During the interviews several participants described ADAS functionality that was not corroborated by the information in the owner's manual.

Two participants told the researchers that the blind spot warning in their vehicles provided an auditory alert along with a visual indicator. However, the owner's manuals for these vehicles only described the visual indicator. Both participants no longer had the vehicle involved in the incident, so it is possible they were misremembering how the BSW operated or were confusing it with another type of alert.

One of these participants also told us that their vehicle had "all of the bells and whistles, the assist and everything." "It was an auto vehicle… it was literally turn it on… and everything was on." When asked to explain what they meant by that statement, the participant said, "When you first turn your car on, this particular car would ask if I wanted all of activation "on" or "off." And I would press "on" to activate everything that I had chosen prior to that." However, the researchers' review of the manual and other materials from the manufacturer, as well as a subsequent conversation with a colleague who also owns a vehicle from this manufacturer provided no evidence to support the participant's description of functionality that allows the driver to turn "on" all the ADAS features with a single action.

The participant who described a tug of war with their ADA (Incident #4), stated, "I know… in order for it to… stop making you correct, you have, like, both hands on your steering wheels and it will detect like that you are, have control in and you're aware of this, so it'll like ease off. Whereas when I had the accident, it felt like, I had both hands on the steering wheel and it didn't make me feel like I was in control." The owner's manual for this vehicle states the driver should always have their hands on the steering wheel when the ADA feature is active and gives no indication that a specific amount of resistance against the steering wheel will deactivate the feature.

The participant involved in a near-crash with an oncoming vehicle that had crossed the centerline (Incident #2) told us it was "disappointing" that they had not received a forward collision warning. After the incident happened, the participant sought additional information. "I thought that [FCW] would detect a body in front of the vehicle and it wouldn't make a difference what it was. And now, and even looking at the manual, looking at the [manufacturer] website, looking at the [manufacturer] forums, I'm concerned it only detects if I'm behind the vehicle, approaching the vehicle. So, if something quickly comes in front, it won't detect that and give me the alert."

Self-Rated Understanding

During most interviews, the researcher asked the participant to rate on a scale from 1 to 5 their level of understanding of the ADAS on the vehicle involved in the incident. Even though nearly all the participants provided ratings of 4 or 5, many of the interview participants acknowledged gaps in their understanding, particularly with respect to how the ADAS work.

One participant qualified their rating of "four to five" by adding, "What they're supposed to do, what their function is, I feel very comfortable with. I understand that like there's kind of a radar and it senses the things around me. But like, how it applies the brakes, I got nothing for that." Another participant told us, "I understood what they were... I can almost give it a 5, but I mean, like, as far as understanding what they do. Yeah, I get that. But could I explain it to you, what they're supposed to do? No, I couldn't." This same participant said, "I don't turn nothing off on my car 'cuz I really don't know how to."

A participant who gave a rating of "probably about a 3 1/2 to 4," explained, "Probably because there's a lot more to, if I were to really look at the manual, I probably would learn a lot more about what they really do and how to properly use them." Another participant, who had rated their understanding of blind spot warning as a five, later stated that they did not know where the sensors for the blind spot warning were on the vehicle. Yet another participant rated their understanding of ACC and BSW as five but later told us, "I assume [the sensors for the blind spot monitors are] on the mirror, but I don't know why I would believe that. I assume [the sensors for the cruise control are] the same kind of sensors at the front on the bumper." Neither of these assumptions are correct. This participant was also uncertain whether their BSW system gives a different indication to a car in the blind spot while the driver is using the turn signal.

Effects of ADAS on Driving

Nearly all the interview participants were asked, "Do you think having any of these features has changed the way you drive and if so, how?"

Only one participant, who was operating their spouse's vehicle during the incident, stated that the ADAS has not changed their driving. Another participant shared, "I don't think it's changed… I feel like a safer driver, but I can't really say it's changed the way I drive."

Several people indicated that having ADAS makes them more confident. One stated, "I was pretty cautious to begin with. As I get older, I think it makes me feel more confident, especially at dawn and dusk, to have those additional features. just because my eyesight is getting worse and it's nice to have, you know, I'll call it another set of eyes helping me drive." Another provided, "I feel more confident in driving… I've been driving for a while and I'm increasing in age and there might be a time where I'm not quite as attentive, so it's nice to know that there's something there to help with that."

One participant said they had confidence they would be alerted to potential crash situations in front of their vehicle. This same participant noted that they were less active in passing when using ACC compared to when they had used conventional cruise control. Another participant shared they were less likely to tailgate after experiencing FCW.

One participant who regularly used ACC and ADA noted, "I think it probably makes me, I would say, a little bit lazier because I feel like it's helping me more. I wouldn't say that it's made

me dangerous… I'm not willing to, like, try to take a nap or anything." The participant added that they feel more relaxed and would not like having to drive without the ACC.

One participant admitted they have become complacent with checking their blind spot with BSW. Another told us that they completely relied on the BSW, "I only had the car about two months, and I actually relied on [the BSW]. I mean so much so where I wouldn't even look anymore to pass lanes." When describing the incident they had been involved in, the same participant stated they were sure their vehicle was still in the original lane because the LDW had not activated to inform them the vehicle was leaving the lane. Finally, one participant said that ADAS "makes you a little bit more… not attentive to the road… It just makes you too comfortable."

Other Descriptions of ADAS

Throughout the interviews, motorists described the ADAS on their vehicles in different ways.

As mentioned above, several drivers described ADAS as being helpful for both safety and workload. One driver said, "We take some extended trips, sometimes driving up to 10 plus hours a day. So, you get a little fatigued there and when you're on a long stretch of Interstate and your attention might be less than what it normally is, [ACC]'s kind of my security blanket. I use it to make sure that just in case I'm distracted or not paying as much attention as usual, that I'm not getting too close to somebody else." Another said, "I think they're just helpers in general."

One participant said LKA was "a neat feature" and went on to describe a time when the activation of LKA signaled to the participant that they were "getting a little drowsy" so they switched drivers and took a break.

Some of the participants described the systems as though they were people. One described their LKA as, "it's kind of dad-like. it's sort of like… when you're learning to drive with your dad, and you're getting a little too far over and he kind of just gently pulls the steering wheel to get you corrected over." Other descriptions mentioned that the ADAS will begin "hollering at you" "when it feels that there's a warning" or "it lets me know if it's not happy" or "If you get close to something, it has a fit." Another participant told us, "There have been times when, like, people would stop in front of me, like, super fast. And [FCW] didn't like it." The participant who had a crash while ADA was active (Incident #4) reported that, "it felt like [the vehicle] had its own mind and control."

ADAS and the Purchasing Experience

The researcher asked each of the interviewees a series of questions about the purchase of the vehicle that had been involved in the crash or near-crash incident. Eight of the vehicles had been purchased new from a dealership while the other two had been purchased used from a used car business and through a private party sale.

Importance of Purchasing a Vehicle with ADAS

The interview participants were asked, "How did the ADAS features on this vehicle factor into your decision to purchase the vehicle?"

One participant said the ADAS features were a very important factor. "100%,... one of the reasons I bought that vehicle was for all of the features," and specifically mentioned blind spot warning, lane departure warning, forward collision warning, backup cameras, and sensors. Three

others noted the presence of the ADAS was a positive but not critical factor when they were deciding whether to purchase the vehicle. One told us, “It wasn’t a large [factor], I mean, if they did not have those features, I still probably would have purchased the vehicle... Having all the other ADAS features was certainly a benefit.” Another participant shared, “The pricing and the inclusion of the safety packages played a part in [the decision to purchase the vehicle].”

Two participants reported that it was very important to purchase a vehicle equipped with ACC and one pointed out, “I don't even know if you can get adaptive cruise without some of the other things.”

Two participants said the presence of ADAS did not factor into their decision to purchase. “It really didn't… I didn't realize it had all of these features until I was already set on buying it and the salesman was kind of filling me in on [the features].” One participant told us their spouse had identified candidate vehicles for the couple to test drive but the participant told us, “I just don't need all the fancy things.” The participant who had been borrowing their spouse’s vehicle when the incident occurred said they had not been involved when the vehicle was purchased.

Knowledge of ADAS Before Purchase

The researcher asked the participants what information they knew about ADAS prior to purchasing their vehicle. Participants described doing research online, having prior experiences with ADAS in other vehicles they had driven, getting information from the sales staff at dealerships, and experiencing ADAS during test drives.

The participant for whom the ADAS features were very important, reported they had done some research online before going to the dealership. This person wanted to purchase from a specific manufacturer and was comparing different models for that brand. The manufacturer’s website had a “safety video” on the website, which described, “blind spot, backup camera, lane departure, pre-collision, cruise control.” The dealership did not give the participant any additional information about ADAS other than giving them the brand catalog. The participant commented, “I think the dealership was more interested in selling me add-ons.”

One participant, for whom purchasing a vehicle equipped with ACC was very important, reported they had selected a specific manufacturer due to its reputation for safety. Before purchasing a used vehicle through a private party sale, the participant looked at the manufacturer’s website, online forums targeting that brand, and YouTube videos posted by actual owners. When the participant purchased the vehicle, they did not discuss the ADAS features with the seller. “I guess I just assumed I already knew everything about it.”

The other participant for whom purchasing a vehicle equipped with ACC was very important had other ADAS-equipped vehicles in their household. “As far as the adaptive cruise, my [spouse] had that on one of [their] cars, so I knew about it, what it was, how to use it.” Their spouse also “had a car with collision avoidance. So, I'd probably heard about it from that.”

Two participants mentioned having some prior experience with technologies in vehicles they drove for work. “With my old job, we had like company cars, and so I kind of learned more about the technologies,” specifically noting ACC and “the lane centering one.” The other participant stated, “my work truck was all like super high tech,” without elaborating on which ADAS features it had. This participant purchased a used vehicle from a business they well and reported they did not learn about the ADAS or discuss them with the seller.

Another participant reported they might have heard about ADAS before, but didn't learn about it until they started researching new vehicles. "I pretty much just learned about the safety features through the [manufacturer's] brochures and website. I didn't do a lot of external reading specifically on the safety features." This person said the sales staff at the dealership "mentioned" the ADAS in "the long laundry list" of features, including cup holders and flip down seats. This participant asked the salesperson questions about the ACC and wanted to verify the vehicle also had conventional cruise control, in case they "couldn't stand" the ACC.

One participant told us, "The salesperson did a good job explaining some of the features. It was the same person that we had purchased our previous car from. So he knew what we were coming from and going to. He did a nice job explaining the new features, the things that we wouldn't be expecting." The salesperson drove the vehicle first and had the participant and their spouse observe while he explained and demonstrated lane keeping, blind spot warning, and parking assist. Then the participant was able to drive and experience some of the features with the salesperson still in the vehicle to provide guidance.

Three other participants described observing at least one ADAS during a test drive prior to purchase. One participant who was specifically interested in purchasing a vehicle with ACC was able to use it, as well as LDW, during their test drive. "When we went on a test drive, I believe they talked about [ADAS]. Not as like an informational thing, but kind of more as a selling point, I think." Another participant told us they experienced the "autocorrect" (i.e., LKA) during their test drive with a salesperson. The third participant completed a test drive without being accompanied by a salesperson. However, the salesperson had explained LDW, BSW, and FCW/AEB before the participant and their spouse went on their test drive. During the test drive, the participant observed only the BSW. This salesperson also tried to explain the magnitude of the braking when AEB is activated. "He made a point to let me know, like, the braking system is pretty sudden… the car will do everything it can to make sure you're not going to hit" whatever is in front of it.

Information from the Dealership after Purchase

Two participants received an orientation from dealership personnel after purchasing their vehicle. One described sitting in the driver's seat while the car was parked and the person from the dealership pointed out different buttons and went over the ADAS "at a high level." It was not "super thorough" but "I felt like I knew how to turn it on." The other participant said, "They kind of just briefly touched on, like, what buttons, and like, how to enable it and disenable it, and then how that kind of looks like on the dashboard." Four participants said they received no additional information about ADAS after they decided to purchase the vehicle. The two participants who had purchased used vehicles both reported they did not ask the seller for information about the ADAS, and the remaining two participants said their spouses had interacted with the dealership to purchase and take delivery of the vehicle.

ADAS Learning Experiences after Purchase

During the interviews, the researcher asked the participants questions related to how they learned about ADAS after they had purchased their vehicles.

Owner's Manuals

The interviewer asked each motorist about the owner's manual for their vehicle.

At least three participants described trying to use their owner's manual to learn about ACC, LDW, or LKA. One of these was the participant who had purchased their vehicle through a private party sale. They said the manual was very "convoluted," so they decided to go back to YouTube for information.

One participant told the researchers that their vehicle did not come with a physical manual. Rather, the dealership gave them a piece of paper with a link, which they had not accessed. Three participants said they have not read the manual for their vehicle while another said they had skimmed it. Several of these participants shared, unprompted, that reading information about ADAS in the manual would probably be beneficial.

Several people said they had used the manual to find information about other things on their vehicle but not any of the ADAS. One of these mentioned that they were able to access their manual on their phone through an app provided by the manufacturer and they found it useful. Finally, at least two participants reported that they have multiple owner's manuals for their vehicle.

Experiential Learning

More than half participants described learning about the ADAS by driving their vehicle.

Several participants described their experiences of learning while using ACC. One pointed out that although the dealership staff had explained how to engage ACC and set the gap, they had to experience the different gap settings while driving to decide which they were comfortable with. A second participant commented, "It took me a little bit to figure out how to set the sensitivity of the [gap for the ACC] system." Another motorist described their experience of getting used to ACC detecting and slowing down for vehicles ahead and how "how quickly it gets on the accelerator" when the vehicle moves into an open lane, which was "just a little bit different in those situations than I would expect." Two participants described experiences where they had not noticed that ACC was following a slower vehicle ahead and then realized they were traveling much slower than they expected.

Several participants described their experiences of learning while using their lane support systems. "I had to try it a few times on my own. you know, out on the road. There's a gentle curve, take the hands off the wheel. It'll start beeping and it will actually nudge it back into the direction that you're supposed to go to keep yourself in the lane." The same participant told us, "Sometimes our daughter borrows the car. If she were to experience that [nudge from the lane keeping], she might not understand. It's a little bit of a learning curve on that one." In addition, this participant described times they had observed their lane keeping system be "fooled" by a line of tar or areas where temporary lane markings had been removed. Another participant described how it "was a little bit more problematic" to select settings for the lane support systems, noting that the three levels between "not on" and "driving itself… seem to be almost the same." One participant told us they drove with their lane keeping system for "maybe an hour" before deciding to turn it off. "If you don't signal, the car just assumes that… you're merging accidentally, and it will move the steering wheel and kind of make it more difficult to move it in the direction you want. I didn't like that."

More than half the participants described experiences they had had with forward collision warning. Several characterized the FCW system as being "sensitive" and described situations when the FCW had activated, including "unnecessary" alarms. One participant reported, "One

thing that [FCW] does not do well is when you're approaching somebody that you can tell is turning into a driveway, for example. And I can tell that my current rate of speed is fine… that the car will be into the driveway and out of the lane by the time I get to it. I've seen times where the system will go off." Another participant described FCW activating for oncoming vehicles when driving on curvy rural roadways. "So, depending on where I'm at and the other car, I think it kind of just picks it up weird cause the road is curvy, but I never had any issues with it." Despite receiving alarms when they were not needed, none of the participants reported they had disabled or wished they could disable the FCW. One participant reported that their incident was the first time they had experienced the FCW. Two participants who had driven their vehicles for only a few months before their incidents reported they had never experienced FCW in their vehicles.

Two described learning about the ADAS on their vehicle in general. One of these participants said, they had learned "just by driving the car and exploring them," because "I am a better hands-on learner." Another said, "I catch on quick with things" and that they understood the ADAS on their vehicle within "days" or "hours."

Time to Reach Understanding of ADAS

The amount of time required to understand their ADAS varied widely between individuals. The participants most often estimated they reached their current level of ADAS understanding within the first few months of ownership. However, one participant who had also independently sought a lot of information about their vehicle and read their owner's manual reported it took about 9 months to reach their current level of understanding of the ADAS generally and estimated 12 months or more for the lane support, citing the complexity of the settings for that system. On the other end of the spectrum, the participant who had been driving their spouse's vehicle during the incident estimated that they started to anticipate when the FCW would activate after driving the vehicle about three times. As mentioned above, another participant said they understood the ADAS on their vehicle within "days" or "hours."

Other Learning Methods

Several participants mentioned discussing or asking their spouse questions about the ADAS on the vehicle. However, none participants reported that they had learned about ADAS from friends or family members outside their household. One reported they had learned about ACC limitations when they participated in another ADAS research study.

Most Effective Learning Method

The interviewers asked the participants to identify what method of learning about ADAS was most effective for them.

Only one participant said they found the breakdown of steps provided in owner's manual to be the most effective learning method. "It really broke it down in steps, what were the different settings for the lane departure and the pre-collision alert."

One participant, who had experience with ADAS on other vehicles in their household and had received an orientation from the dealership said, "It's nice to have kind of a foundation to start off of, rather than just completely trial and error." Three other participants indicated they learned best through hands-on experience with the system. The participant who had seen the ADAS

demonstrated during the test drive experience said they were a visual learner and found it helpful to see “somebody do the process.”

The participant who had purchased their vehicle through private party sale told us they found the YouTube videos from another owner to be the most informative. “I wanted real life. I didn't want [manufacturer] telling me your car was safe. I wanted someone who drove a [make] to tell me it was safe.” If they were to purchase a car from a dealership in the future, they would want someone from the dealership to “literally get into the car and show me what this is” and “worry about that more than trying to just sell the car.”

Information that would have been Useful to Know

During the interview, the participants were asked, “Is there anything you know now about the ADAS features on your vehicle that would have been useful to know before you purchased or began driving?”

One participant told us, “I wasn't knowledgeable on the systems at the time of purchase. In hindsight, I would have more questions.”

Three participants said they wished they had received more information about what to expect from their collision avoidance features. One suggested a demonstration or a video from the driver’s perspective of what happens during a forward collision warning.

One said they would have asked the dealer for a demonstration and explanation of what lane keeping assist does and how to change settings. They also said they would have liked to have been given information about the limitations of ACC. Another participant who had described how the “lane detection” would turn on automatically when the cruise control is on, even after they had clicked the button to disable the lane feature, said they would have liked to have known how “the cruise control and how like the lane assist kind of tie in together.”

One participant who had experienced sensors turning off due to ice and snow accumulation on their vehicle said “I mean, we live in Iowa and it does ice. Now, I know those front sensors get covered. I don't know if that's the case with different brands, but in hindsight, if I had to go back, I probably would have looked at different brands of vehicles and see if there were any that had something to you prevent that from happening.”

Finally, one of the participants said they would have liked more information about what the lines in the backup camera display indicated.

Design Feedback

The researcher asked participants, “If you were talking to a design team, what feedback would you give them regarding the ADAS systems on your vehicle? Are there any changes that you would suggest?” In addition to design suggestions for adaptive cruise control, lane support systems, and blind spot warning, the participants had feedback about sensors and diagnostic tools.

Two participants had design feedback about how adaptive cruise control functions. One felt the rate of acceleration used by the ACC is too high. The other participant suggested that ACC provide indicator to driver that the system is slowing down. “They could maybe put a sound alarm on, if it slows down, something like that, or they could put a light on… I didn't know anything till I looked down and saw I was going 20 miles slower than I was [before].”

Participants offered five different suggestions for lane support systems. One idea was to design lane systems so they can work when the system has detected only one lane line. Another participant suggested designers should continue to improve lane keeping features so they "get fooled" by tar lines, temporary lines, and sun glare less often. A participant who uses lane centering assist suggested allowing the driver to adjust their preferred lane position. "[LCA] hugs the center line more than I would like… I would like to be able to adjust it, cause it when that's turned on, if I try to keep it more over to the right, which is just kind of where my comfort zone is, it will kind of fight you and it wants to center you right where it wants to." The same participant also stated they would like to have another kind of "notification" from the "lane keep" "I don't necessarily like how it kind of shakes the steering wheel." They mentioned how some vehicles use a seat vibration instead. Finally, the participant involved in Incident #4 while using active driving assistance noted drivers should be able to control "lane assist" separately from cruise control. "For like lane assist, I would have either, like the option on or off, and then not have it with kind of like in partner of like the cruise control."

One participant felt the amber color of their blind spot warning was "subtle". "The proximity sensor on my rearview mirrors. It would be nicer if it was not an amber color, because if it were something more noticeable, I would like that... something that would be unusual, like a bright red or a green."

Three participants suggested making changes so sensors would be less affected by ice, snow, slush, leaves, and dirt. One participant described driving through a "slush storm" that covered their sensors. "The car was incessantly telling us to clean the sensors, even as we were driving down the road… It would be nice to disable or be able to at least acknowledge that situation [to stop the notifications] without having to stop and clean [the slush] off." Another participant who had also experienced their sensors being impacted during winter weather said, "The first thing I would tell a design team… "build a vehicle that the sensors are not gonna become covered in ice or snow." The same participant noted, "In the fall, when the leaves happen to be on the ground. If you're pulling out of your driveway and it's windy and the leaves are flying all over the place, those sensors will go off." The third participant, whose residence is on a gravel road, wished there was something that could be done so the sensors are not impacted when the car is dirty.

Finally, the participant whose vehicle had vehicle braked unexpectedly in Incident #3 suggested making design changes so it would be possible for mechanics to determine why an ADAS had behaved in an unexpected way. Since the service providers at that dealership could not identify what had caused the incident, "Maybe the auto manufacturers could make it a little more specific as far as diagnostics."

Discussion

The interviews conducted for this project examined 11 different crash and near-crash incidents. The researchers determined that ADAS helped prevent at least two collisions but likely contributed to two other incidents. There were also incidents where the ADAS might have been beneficial or had no effect. The most common type of incident was front-to-rear near-crashes.

The motorists in this study had varying levels of understanding. Some motorists had incorrectly identified the ADAS on their vehicles when they completed the survey. During the interview, many participants did not know what to call their ADAS systems. For the most part, the interviewees used neither the generic names nor the manufacturer's names. Some used labels that

conveyed capabilities the systems did not have. Several motorist participants conflated the functionality of different systems ADAS systems. While describing the functionality of their ADAS to researchers, some participants gave information that contradicted what was described in the owner's manuals and that contradicted their own ratings of how much they understood their systems. Two participants who were in injury crashes had only their vehicles for a few months. Both shared information during their interviews that indicated to the researchers they had misunderstood how their ADAS worked. Multiple participants said that having ADAS made them feel more confident as a driver, while other participants acknowledged that ADAS had affected how they drive, including becoming complacent with checking their blind spot, reducing how often they pass other vehicles, and being less likely to tailgate other vehicles.

ADAS was not a high priority for most of the buyers, though several said the presence of ADAS was a benefit. Eight of the vehicles were purchased new from a dealership and the participants described a wide range of dealership experiences. At one end, one participant and their spouse received a customized demonstration drive, and at the other, the dealership staff just listed the ADAS among the vehicle features without providing any information about them. Only two participants got an orientation to their ADAS after the vehicle was delivered to them. Multiple participants said they wished they had learned more about forward collision warning and AEB and lane support systems before they had purchased their vehicles.

Very few motorists had read the ADAS information in their owner’s manuals. Motorists preferred learning about ADAS by driving the vehicle or watching someone else demonstrate the systems.

Although the interview methodology was time and labor intensive, it provided many benefits over only collecting survey data. The survey is dependent on respondents paying close attention to the survey items, which can have nuanced differences. Many of the survey responses did not provide enough details for the researchers to gain a solid understanding of what happened during the incident and many motorists gave responses that did not correspond to the ADAS the survey items were asking about (e.g, describing a collision alarm as part of active driving assistance) or were unable to provide descriptions of what the ADAS did or was expected to do during the incident.

The interview methodology allowed the researchers to get clarification about what occurred during the incident. On several occasions the way the incident was described during the interview was vastly different than how the research had interpreted the description the motorist had provided in their survey. Many of the survey respondents had misclassified their incidents with respect to whether it was a crash or a near-crash and what type of crash they had or would have had. After completing the interviews, the researchers changed the incident type as reported in the survey instrument for 5 of the 10 incidents. Similarly, the interview process allowed the researchers to better understand the ADAS that were or were not involved in the incident. Discussing the ADAS at length with the participants allowed the researchers to become familiar the participants’ mental model of each technology. Finally, the process of preparing for interviews highlighted how difficult it can be to determine what ADAS is on a vehicle. For most subject vehicles, the researchers used two or three different VIN decoders, the owner's manuals, and two to four additional information sources to decide what features were most likely to be equipped on the vehicle.

A limitation of the motorist arm was a lack of Colorado crashes or motorists. The motorist survey asked respondents to provide the name of the state where the crash or near-crash incident occurred but not the state where they reside. None of the incidents discussed in the interviews took place in Colorado and nine took place in Iowa. While we do not know where the motorists who completed the survey reside, only three of the incidents occurred in Colorado compared to fifty-two in Iowa, and fourteen in other states. However, the only recruitment method that could be deployed in Colorado was CDOT's social media posts.

OFFICER ARM

This arm of the project aimed to gather information from law enforcement officers about the investigation of crashes that involve passenger vehicles that are known to be or that could be equipped with one or more ADAS. Officers could choose between completing a survey or an interview. Both methods covered the same topics: the officer's understanding of advanced vehicle technologies, their approach to ascertaining the role that ADAS features may have played in contributing to or mitigating a crash, how they include ADAS-related information on the crash report, and training they may have received in the past or would like to receive in the future. A total of 75 officers completed either the survey or the interview. Both descriptive results and qualitative findings are reported.

Methods

Law enforcement officers were invited to complete either a survey, which took approximately 10 minutes to complete, or an interview, which was about 45 minutes in duration. The interview method allowed the research team the ability to ask follow-up questions and learn more detailed information. All research methods for the officer arm were reviewed and approved by the University of Iowa Institutional Review Board.

Procedures

To be eligible in participate, a law enforcement office had to be:

- employed as law enforcement officer in either Iowa or Colorado, and
- have completed at least one motor vehicle crash report in the last three months.

The research team shared study information with officers through several recruitment methods:

- Distribution of postcards at the Iowa DOT's Traffic Incident Management Conference
- Email announcement sent by the Iowa State Sheriffs and Deputies Association to their membership and to each county's Sheriff Office
- Email announcement sent to the membership of the Iowa Police Chiefs Association
- Email announcement sent to the law enforcement partners of the Colorado Highway Safety Office
- Email announcements sent to the sworn personnel of the Iowa State Patrol and selected personnel of the Colorado State Patrol
- DSRI social media

All email announcements asked the recipients to consider forwarding the study information to the officers employed by their agency. However, the research team has no direct knowledge of nor any way of determining whether any individual agencies (other than the state patrols, as described above) shared information with their officers.

Online Instrument

All recruitment materials included a link to an online survey instrument that was administered using REDCap electronic data capture tools hosted at the University of Iowa (Harris et al., 2009). The full instrument can be found in Appendix F. Officer Survey. The REDCap instrument included:

- screening questions to determine eligibility,
- information about the study,
- consent to provide information,
- invitation to learn about and volunteer for an interview, and,
- if the respondent declined interest in completing an interview, an invitation to immediately complete the 10-minute survey.

As described above, the survey included questions about these topics:

- the officer's understanding of advanced vehicle technologies,
- their approach to ascertaining the role that ADAS features may have played in contributing to or mitigating a crash,
- how they include ADAS-related information on the crash report, and
- training they may have received or would like to receive.

The portion of the survey that asked about crash reporting was customized for the state where the participant worked. The State of Colorado Traffic Crash Report (version dated 11/24/2020) includes a data element titled, "Autonomous Vehicle Capability" with codes labeled No Automation, Driver Assistance, Partial Automation, Conditional Automation, High Automation, and Full Automation. There is also a checkbox labeled, "Driver Ceded Control of Vehicle." Iowa's Investigating Officer's Report of Motor Vehicle Crash Form does not include any data elements related to driver assistance or automation.

Interview Procedures

A researcher emailed each interview candidate inviting them to complete a brief REDCap survey, which asked them to verify they were still interested in participating in an interview, and if they were, to provide days and times they were available for the interview. Then the researcher emailed the participant with the date and time of the interview appointment along with instructions about how to join the virtual meeting.

The interview appointments were scheduled for 45 minutes. Upon joining the phone or video call with the participant, a researcher described the interview procedures with the participant. After the researchers answered any questions from the participant, the researchers conducted a brief test to verify the recording equipment was working properly. The virtual interviews were conducted, recorded (audio and video) and transcribed via Microsoft Teams. One researcher (MR) conducted the interview with the participant while the other researcher (CR) monitored the interview and the recording equipment and suggested additional follow-up questions for the interviewer to ensure that all the interview topics were adequately covered. The interview guide can be found in Appendix G. Officer Interview Guide.

Transcript Procedures

The researchers followed the same transcription procedures for the officer interviews that were described above for the motorist interviews.

Summarization of Themes

The officer interviews were more structured, so themes primarily corresponded to the topics covered by the interview guide. Using an initial list of themes based on the topics, one researcher

(CR) read through each subject's interview script and summarized the pertinent information with respect to each topic along with any novel themes. Then the first researcher used the summary to identify exemplar statements for the various themes. The other researcher (MR) reviewed the summaries and the transcripts and identified subthemes. Both researchers reviewed open text responses from the survey and associated them with the themes that had been identified.

Participants

The REDCap instrument was accessed 239 times. Four individuals were ineligible because they were not employed as a law enforcement officer and 39 individuals reported they had not completed at least one crash report in the last three months. A total of 201 individuals met the eligibility criteria to participate and 140 gave their consent and agreed to provide information for the research study. In all, 75 participants completed either the survey or an interview. These participants are summarized in Table 15.

Sixty-six officers completed the survey. All but three respondents reported that they work in Iowa, and 73% were affiliated with either the Iowa State Patrol or the Colorado State Patrol. Seventy percent of the officers had over 10 years of experience, while another 15% reported between five and ten years of experience. In the last three months, 55% of the survey officers reported they had completed less than 5 crash reports, 21% had completed between 5 and 9 reports, and 25% had completed at least ten crash reports.

Sixteen respondents indicated interest in completing an interview and all were invited to schedule an interview time. Seven individuals did not respond after multiple emails from the research team inviting them to complete the interview. Researchers completed nine interviews with officers.

Six of the nine officers who completed an interview were employed in Iowa and three in Colorado. As with the survey participants, most of the officers (n = 6) worked for one of the state patrol agencies. Seven officers had over 10 years of experience doing crash reports and two officers estimated they had completed at least 20 crash reports in the last three months. Five of the interview participants were crash reconstructionists or technical investigators

Table 15. Characteristics of participants in the officer arm

Characteristic	**Survey participants** ***n (%)***	**Interview participants** ***n (%)***	**Total participants** ***n (%)***
State where officer is employed			
Colorado	3 (5%)	3 (33%)	6 (8%)
Iowa	63 (95%)	6 (67%)	69 (92%)
Years of experience with crash reporting			
Less than 1 year	3 (5%)	0	3 (4%)
At least 1 year but less than 3 years	3 (5%)	1 (11%)	4 (5%)
At least 3 years but less than 5 years	4 (6%)	1 (11%)	5 (7%)
At least 5 years but less than 10 years	10 (15%)	0	10 (13%)
More than 10 years	46 (70%)	7 (78%)	53 (71%)
Number of crash reports completed in last 3 months			
Less than 5	36 (55%)	3 (33%)	39 (52%)
At least 5 but less than 10	14 (21%)	4 (44%)	18 (24%)
At least 10 but less than 20	15 (23%)	0	15 (20%)
At least 20	1 (2%)	2 (22%)	3 (4%)
Agency type			
State patrol	48 (73%)	6 (67%)	54 (72%)
County sheriff	14 (21%)	2 (22%)	16 (21%)
Local policy department	4 (6%)	1 (11%)	5 (7%)
Total	**66**	**9**	**75**

Results

This section presents results about the officers' understanding of ADAS, whether they consider ADAS during crash investigations and the reasons for doing or not doing so, crashes where ADAS may have had an impact, reporting ADAS in crash reports, ADAS training, and personal experience with ADAS. The results combine and summarize the officers' responses from both the survey and the interviews. However, the bar charts and frequency tables only include survey responses.

ADAS Understanding

Officers who completed the survey were asked to give their definition of ADAS and were presented with several items that asked them to rate their agreement with different statements related to their understanding of ADAS.

Definitions of ADAS

Researchers identified several themes and patterns in the definitions of ADAS given by the survey participants.

Nine participants (14%) did not provide a response. Fourteen officers (21%) provided a response that did not include a definition of ADAS, with most explaining they were not familiar or had little to no experience with ADAS. One of these conveyed the officer's opinion but included a reference to "safety features." Thirteen officers (20%) did not provide a definition but provide different examples of ADAS. Thirty officers (45%) provided a definition, though one provided a definition that was copied from another source.

The two researchers agreed that four of the ADAS definitions given by officers were incorrect. One participant defined ADAS as the process that a technical investigator would perform to retrieve data from a "black box." Another said ADAS was the "'infotainment' system often comprised of a large… screen… with apps." Two other incorrect definitions were "self driving vehicles" and equipment "that does not require the driver to be actively engaged in the vehicle's safe operation." The researchers excluded the responses with the copied definition and the four incorrect definitions from further analysis.

Within the 29 responses with retained definitions and/or examples of ADAS,

- 16 included content that referred to the "lane," e.g., lane departure or lane assist
- 15 referred to braking functionality, e.g., automatic braking or brake assist, and
- 10 mentioned collision prevention, avoidance, or mitigation.

A smaller number of responses said ADAS "help" in a variety of ways or mentioned "safety" features, adaptive cruise control, steering functions, warning, sensors, radar, cameras, vibrating seats and pedestrian detection. A few of the definitions included terms that might imply some negative perceptions, including "seemingly safe safety features" and "'Nannies' that help reduce collisions and make cars safer."

The interview participants were not asked to provide definition of ADAS but two officers reported that they were not familiar with the term. One said, "I gotta admit, I'm not really so sure I'm real knowledgeable about what ADAS really is… I actually I had to look up what the heck ADAS stood for when, when I got this email." Another said, "When I got the email for the study,

that was the first time I heard the acronym," though the officer went on to explain they were aware of some of the technologies in vehicles. Another officer said, "If somebody gave a statement that their vehicle did something that they were not prepared for [during a crash], I would consider that… [but] I'm not familiar with any of the… capabilities on a street level or a patrol level where that would come into play."

Understanding of Different ADAS

In the survey, officers rated their level of understanding for each of the ADAS identified in Table 1. While considering the purpose, function, and limitations of the ADAS, a rating of 1 indicated a very low level of understanding while a rating of 6 indicated a very high level of understanding. Ratings of 1 and 2 were combined into low understanding, ratings of 3 and 4 into medium understanding, and ratings of 5 and 6 into high understanding. As shown in Figure 1, officers reported higher levels of understanding for the warning type ADAS (i.e., blind spot warning, lane departure warning, and forward collision warning) and for adaptive cruise control, and lower levels of understanding for automatic emergency steering and active driving assist.

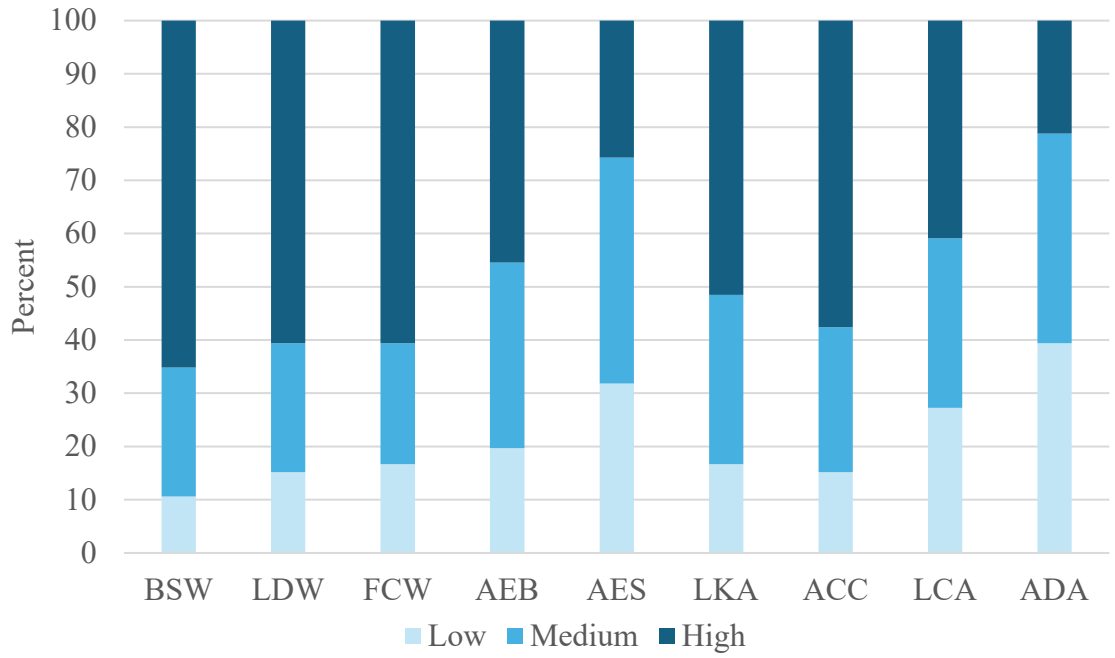


Figure 1. Officers' level of understanding, with consideration of its purpose, function, and limitations, for each ADAS.

Location of Sensors and Cameras

In the survey, officers were asked to rate their level of agreement with the statement, "I know where on the vehicle to look for sensors and cameras used by ADAS." As shown in Figure 2, more than 60% indicated some level of agreement with the statement, but only about 1 out of 7 officers strongly agreed. Those who indicated disagreement were most likely to strongly disagree.

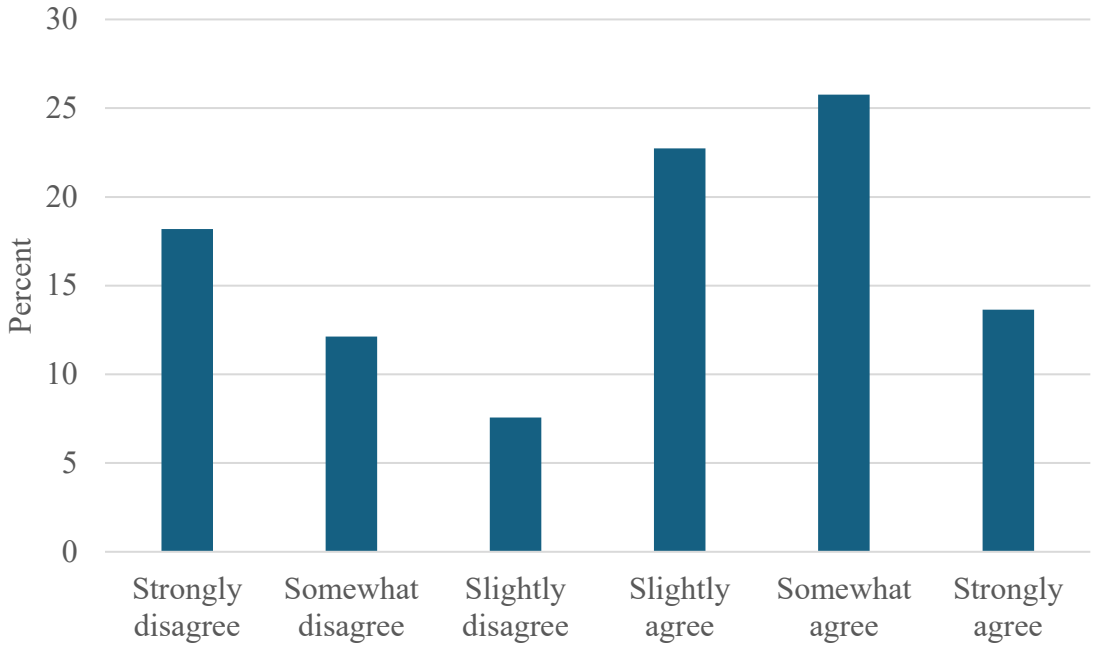


Figure 2. Officers' agreement with survey statement, "I know where on a vehicle to look for sensors and cameras used by ADAS."

Three different interviews included the topic of sensors or cameras. One officer indicated his understanding that a trapezoidal camera near the top of a vehicle's windshield supports lane keeping systems and that radar systems are not very effective "to see through the fog." One other officer described how the "radar system" in a personally-owned vehicle detects when there is a vehicle ahead. A third officer described a crash investigation where they were looking to obtain evidence related to lane position from the vehicle's front cameras.

Difference between ADAS and Automated Driving Systems

Figure 3 shows the level of agreement officers completing the survey expressed for the statement, "I have a clear understanding of the difference between ADAS and Automated Driving Systems." Nearly a quarter of the officers slightly agreed and 29% somewhat or strongly agreed. Responses for strong, somewhat, and slight disagreement were very balanced with about 15% of the participants in each category.

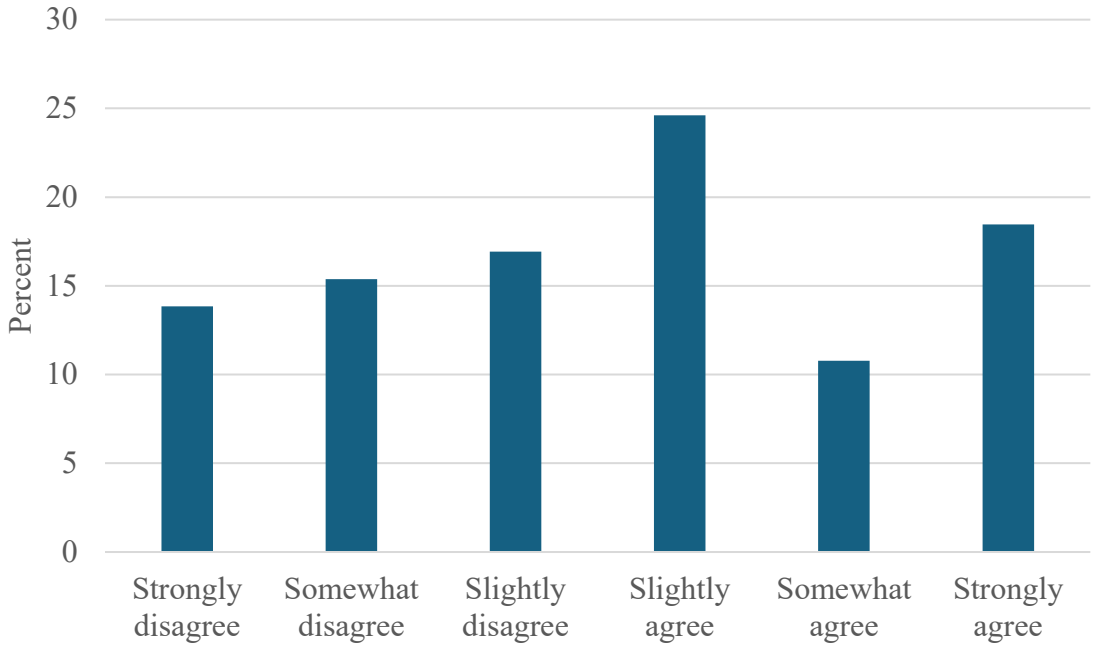


Figure 3. Officers' agreement with the statement "I have a clear understanding of the difference between ADAS and Automated Driving Systems."

Autonomous Vehicles

None of the officers who completed the survey said they had investigated a crash involving an autonomous vehicle. During the interviews, the researcher asked seven officers whether they had investigated a crash involving an autonomous vehicle. Six of these officers mentioned "Tesla" in their responses, though one officer clarified they thought Teslas were only partially and not fully autonomous. The other two officers who were not directly asked about autonomous vehicles also mentioned Teslas in the context of autonomous driving during a different part of their interviews. One stated, "I've never come across a Tesla driver doing the automatic thing yet, but I've heard about it." The other officer described their experience of being "in a Tesla that drove itself."

One officer from Colorado estimated that about 20% of their recent crash investigation involved Tesla vehicles. In the officer's experience, when a driver who has been in a crash mentions a warning or automatic braking, that driver is often a Tesla driver. "And most of the time the reason that they crashed is because they say it 'failed'". The officer also shared their opinion that "people trust those systems way too much," "especially with the 'Autopilot.' That doesn't seem to work as well as it's supposed to, or people hope it to." If the Tesla involved in a crash is equipped with Autopilot, this officer will indicate "high automation" in the AV Capability field, even if the Tesla driver was not using the feature, because "the vehicle had the capabilities of it."

Consideration of ADAS in Crash Investigations

All officers were all asked to provide information about whether they have considered ADAS in crash investigations, the circumstances that might lead them to consider ADAS, and how they obtain information about ADAS during an investigation.

Officers who completed the survey were asked whether they consider ADAS as a routine part of their crash investigations. As shown in Figure 4, only about 8% of officers said they *Usually* or *Always* consider ADAS while 43% of officers reported they have *Never* considered ADAS.

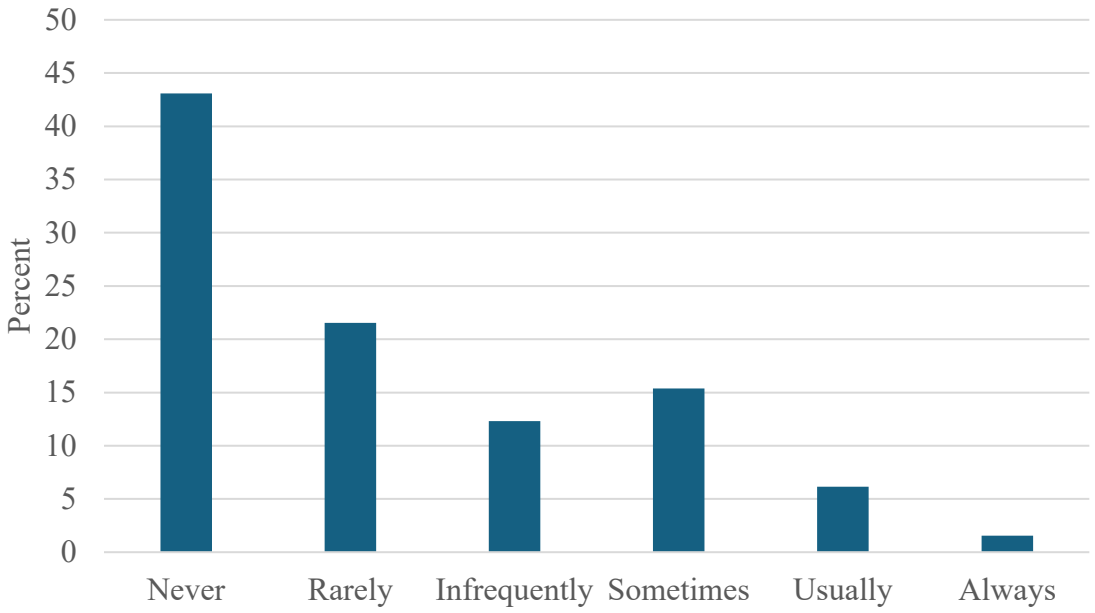


Figure 4. How frequently officers reported they consider ADAS as a routine part of your crash investigation protocol?

Reasons Given for not considering ADAS

Officers who reported they *Never* consider ADAS were asked to explain why they do not. Multiple officers said they were either unaware of the systems or they simply do not think to ask about them when investigating a crash. Some officers said they have not considered ADAS because they have not yet had a crash where it was a factor. At least six officers reported they had not been trained to investigate ADAS. Two of these officers added that they did not know "how to pull that information from the vehicle." Several more officers gave responses that indicated they believed data would have to be retrieved from the vehicle's crash data recorder before they could consider ADAS when investigating a crash. One of interviewed officers said, "For serious crashes, ... sometimes there will be traffic investigators, ... who have the fancy plugins that ... give that kind of information." Another interviewee noted that there is no way for an officer to visually observe on the vehicle, for example through an indicator in the dash, that some system was activated during a crash.

Finally, five officers noted that they do not consider ADAS because they are "irrelevant," because ultimately "it is the driver's responsibility to drive the vehicle." The concept of a driver being responsible regardless of what an ADAS did or did not do came up repeatedly in interviews. "In order for them to have been in a crash, some kind of traffic infraction had to have

occurred. So, it's not necessarily the fact that they had all this technology, it's still the fact that they did something that that caused a crash." Some officers shared their belief that if an ADAS related to crash avoidance was activated, that would indicate some sort of fault on the part of the driver. "I also think part of that may be that's a little self-incriminating. That when they admit the systems took over, there's a reason the systems took over. They're not paying attention. And nobody wants to admit that to law enforcement."

One survey participant reported multiple reasons related to why they *Infrequently* consider ADAS. "I'm not going to pull the data from the vehicle in minor collisions. I'm not going to have probable cause to search the vehicle interior to find these systems. Most owners can't tell you what systems they have if asked. Even if a driver ignored an ADAS warning system … in a minor accident … in this case would only be important to insurance companies." One interviewee also reported that "a lot of our drivers don't even realize they have those technologies." The same officer also pointed out, "For me to get into that vehicle as law enforcement [to get EDR data], that's a search warrant. And am I going to get a search warrant on every individual crash? No."

Circumstances for Considering ADAS

The 38 survey participants who reported that they consider ADAS more than *Never* were presented with a list of circumstances and asked to select any which may lead them to consider ADAS during a crash investigation. A summary of their responses is shown in Table 16. More than half indicated that they had considered ADAS because the *driver told me the vehicle had ADAS.* One interviewee stated, "Unless a driver specifically mentioned something like, you know, my cruise control failed or something like that, it's never gonna get looked into."

Additional reasons selected by the officers during the survey included the *vehicle model was relatively new* or *I noticed cameras or sensors on the exterior*. Officers who were interviewed also most often mentioned considering ADAS if the driver told them about it or if the vehicles was new. One interviewee who was also a technical investigator said, "Newer vehicles... we're usually going to be looking for that because it's getting to be more and more standard equipment nowadays."

Other reasons officers gave included the officer having familiarity with the vehicle model or the crash involving a fatality or serious injury. One said, "thorough documentation of the ADAS systems, in my opinion is only important in instances of serious bodily injury and death," and two other officers remarked on crash injury severity being a factor. Notably, no officers reported that their agency expected them to consider ADAS in a crash investigation.

Sources of ADAS Information During Crash Investigations

The survey presented officers (excluding those had indicated that they Never consider ADAS when investigating crashes) with a list of activities that might help officers learn about ADAS technologies during a crash investigation. Table 17 provides details about these tasks. The most frequently performed task was *obtaining the vehicle event data recorder to determine ADAS status at the time of the crash*. Fifteen out of the thirty-eight officers indicated they had performed this task. Fewer officers reported *performing a VIN look-up*, *obtaining the owner's manual*, or using *other* sources. One officer who completed the survey noted, "Running a VIN check through our normal systems will not tell you if the vehicle has ADAS technology."

Table 16. Circumstances for considering ADAS in a crash investigation

Circumstance	***n* (%)**
Driver told me the vehicle had an ADAS	21 (55%)
I noticed cameras or sensors on the exterior of the vehicle	13 (34%)
Vehicle model year was relatively new	17 (45%)
Agency expects me to include it in my investigation	0
Other	5 (13%)

The *other* sources included contacting mechanics or the vehicle dealership, asking the owner, searching online, NHTSA, information from the manufacturer, YouTube, and crash data retrieval (CDR) for technical investigations. Two crash reconstructionists said they generally rely on the CDR to make the determination about ADAS. One of the officers who completed the survey stated, "If an investigation needs deeper look, we would obtain the CDR box."

The officer who said they had contacted mechanics noted they weren't very knowledgeable and they suggested the officer contact the vehicle's manufacturer. Of the 38 officers who were presented with the survey item, 21 (55%) selected *None of these*.

Table 17. Tasks performed during crash investigation to obtain ADAS information

Task performed	***n* (%)**
Performed a VIN look-up to determine whether the vehicle was equipped with a certain ADAS technology	5 (13%)
Obtained the owner's manual for a vehicle to determine whether the vehicle was equipped with a certain ADAS technology	1 (3%)
Obtained the owner's manual to learn how a specific ADAS technology is intended to function	1 (3%)
Obtained vehicle event data recorder (EDR) data to determine ADAS status at the time of the crash	15 (39%)
Sought information from a different source to help me learn about ADAS technology on a vehicle involved in a crash	6 (16%)
None of these	21 (55%)

Video Data

Another source of information that was discussed during many interviews was video data. One officer described a recent investigation where a fixed camera operated by the Iowa DOT had captured video that disputed a driver's description of events. Several officers described cases

where a crash-involved driver had provided videos from their vehicles' cameras to demonstrate that the crashes were unavoidable due to the actions of others involved. One officer pointed out that if a driver would not willingly provide video, the officers would have to obtain a warrant through a "separate process" than obtaining the data from the crash data recorder. Another officer said, "I have had some people very reluctant to let me see the video, and I can't force them to show me video, so I just leave it at that. But at that point, it's kind of like, OK, yeah, I've gone already confirmed what I already know about what happened." A crash reconstructionist described needing to obtain special software and cables in order to even try to obtain video files from the forward camera associated with ADAS features in a particular investigation. Though the consideration of video data is not necessarily related to the consideration of ADAS, many vehicles with ADAS do have integrated cameras. One officer described a frustrating and unsuccessful attempt to obtain the video data from a crashed vehicle equipped with one of those systems.

Event Data Recorder Challenges

Several of the officers who regularly work to retrieve crash data from vehicles described challenges they have encountered, including not having access to expensive software and equipment. Another theme was the lack of standardization.

The first officer who was interviewed explained that there is standardization of which parameters need to be recorded by an airbag module but the details look different across manufacturers. "When you get the data [from the crash data retrieval tool]… you have to go through usually the very first few pages, known as the data limitations." The officer needs this information to be able to interpret the data and the charts in the report. For example, "the steering input's read as in a negative number and if it's negative that means it's turning left. While the next manufacturer may be completely opposite of that."

Which modules can be read also vary. Another officer shared, "What the manufacturers advertise as data as being available through those features, is not always part of what they store. And that's… highly manufacturer-dependent." This officer described how one of the vehicles involved in an investigation was equipped with a front camera module and another module that controlled the driver assistance, in addition to the airbag module. However, the vehicle was configured in such a way that only one of the three modules could be read by the crash data retrieval software. Therefore, even though the vehicle was equipped with the system and presumably the module contained data about the crash, it was inaccessible. Later in the interview the same officer described how his agency does not possess the software program which is specific to one manufacturer's vehicles. Finally, this officer shared, "These manufacturers are deviating on all their own little paths as to how they approach this problem. You know, what systems are we going to put in a car, or what combination of systems are we gonna put in a car, and they're all answering that in their own way. And everything is going in a different direction and we, on the investigative side, we have very little access to any of it."

Another investigator described a plan they had to source cables in the hopes they would be able to pull video from a module. "I'll be looking today to see if I can harvest the cables on a totaled [vehicle model] to see if I can build my own [cables] with it, because [vendor] is back ordered and hasn't released the cables for us to get access to that video component." The same officer also shared that many times the event data recorder system is destroyed during the crash so data cannot be retrieved.

Another investigator described an investigation that considered ADAS involvement for a vehicle that struck another vehicle in a rear-end collision. “Daylight. Good condition. Four-lane highway, no visibility things or whatever. The [striking vehicle] had adaptive cruise control, so… if cruise was “on”, it should not done that. We were able to find out through [module] data, the cruise was not “on”. But what I never found out was if that vehicle had front collision or not, avoidance or mitigation. If it was always running passively in the background no matter what. Or if it actually did anything, or if just because the speed differential was so high… so to this day that's just five unanswered questions.”

ADAS Involvement in Crashes

The survey asked officers whether they had investigated any crashes where they concluded that an ADAS had impacted the crash, either by mitigating (reducing) the crash severity or by contributing the occurrence of the crash or worsening the severity.

Five officers who were surveyed and three who were interviewed reported they had investigated crashes where they believed that automatic emergency braking may have mitigated the severity of a crash. Five gave specific descriptions of crash mitigation:

- Pre collision braking systems slowed down the vehicle prior to the collision. Driver was not paying attention told me their car gave warning to brake and then started braking prior to collision.
- Brake assist got the drivers attention enough to change lanes and miss a worse impact.
- Crash mitigation system in the vehicle applied brakes within 1.6 seconds of collision, beyond capabilities of human reaction. This slowed vehicle prior to collision, lessening the impact.
- Head on collision with a van. Vehicle braked through the initial impact area as driver was [not responsive].
- Semi with crash mitigation that reduced the vehicle’s speed but it didn't prevent the collision.

Two officers described cases where a vehicle was struck from behind after automatic braking prevented collision with the primary hazard.

- Rear end collision, the first unit had debris in their lane, their vehicle slowed automatically, the second vehicle did not have these safety features and caused unit 2 to rear end unit 1.
- A vehicle in front of unit 1 slammed on the brakes and then cut across the lanes to try and hit an exit. The automated braking prevented unit 1 from hitting the vehicle ahead but unit 1 got rear ended by another vehicle

Four officers identified that an ADAS likely contributed to the occurrence of a crash or made the crash more severe. Two of them identified brake assist applying unnecessarily, which led to a chain reaction of vehicles colliding from behind. Two officers identified that drivers were over relying on the systems.

- A semi with brake assist had a car in front of him cut him off. The driver stated he didn't need to slow down but the truck did anyway. It caused 3 vehicles to run into the back of him

- Crash mitigation system applied brakes to vehicle, causing vehicle to rapidly slow, and cause a chain reaction collision behind it. There was not direct threat in travel lane, but a car in turn lane to right of vehicle.
- The driver relied solely on the ADAS to let them know if there was a vehicle in their blind spot. They did not check their mirrors or look over their shoulder. There was no indication from the ADAS that there was a vehicle in the blind spot, and they changed lanes directly into another vehicle.
- Driver was relying on lane assistance. Approached curve where white line disappeared for an intersection and drove directly off to a curve damaging property and injuring the driver.

A fifth officer gave a general description about drivers relying on technology too much and not looking in their blind spot or claiming they were distracted by an alarm or light that was warning about an obstacle or hazard.

Several additional themes arose when talking to the officers about ADAS involvement during crash investigations. Driver misuse and misunderstanding of ADAS was identified by multiple officers. One indicated that several ADAS-equipped crashes investigations involved drivers performing "intentional acts" at high rates of speed while impaired. Another identified speed as a factor and that the driver operating the vehicle in an extreme manner that was more than any ADAS could mitigate.

Two officers described times semi drivers who had been in crashes believed their ADAS were more capable than they actually were. One driver was blaming their system for not braking enough to avoid a front-to-rear crash, however, the data showed that the system did slow the semi, just not enough to bring the vehicle to a complete stop. The officer thought perhaps the driver was misinformed of the system capabilities. Another officer identified a situation when a semi-truck driver "was using the radar system's forward collision warning to see through the fog, if you will. It doesn't actually work as well as he thought, but he didn't know that."

Several officers stated they believe ADAS is affecting crash frequency. "I have noticed… there's a lot less crashes with the vehicles that have that kind of technology, because in my opinion 90% of the crashes that happen where I work are simply attention oriented. Somebody's not paying attention and the cars with the advanced systems are very good at mitigating that." Another pointed out, "If technology worked in other cases, then they most likely would not have crashed so I might never hear those stories." At least two officers wondered whether impaired drivers are evading notice through the use of lane support systems.

State Crash Report Forms

The survey asked officers about using the crash report form to note ADAS on the vehicle and the impact of ADAS in the crash, as well as soliciting their suggestions for revisions to the crash to record information about ADAS. The results for Iowa and Colorado are reported separately.

Iowa Crash Report

Indicating ADAS in Crash Report

Survey respondents employed in Iowa (n = 63) were asked, “Please describe how you indicate on the Iowa crash report form the presence of ADAS on the vehicle and impact of ADAS on the crash.”

Eleven officers (18%) did not answer the question and three other responses did not include enough information to interpret the officer’s meaning. Nine officers (14%) reported that they have not had to indicated ADAS in a crash report. Eleven respondents (18%) gave a response saying they do not indicate ADAS in the crash report form. One of these officers provided, “We don't, not necessary. ADAS is not an indication of what happened in an accident.” Another stated, “I don't indicate it on a accident report nor have I seen an impact of ADAS on a crash.” Another officer explained, “I do NOT indicate it on the form because I have no way to determine if it was involved.”

Five officers (10%) responded that the crash report form does not offer an option for indicating ADAS. Two officers said they would indicate ADAS in a separate crash investigation document (e.g., technical investigation report) but not in the state crash report form.

Nineteen officers (30%) said they would describe ADAS in the crash report narrative. One officer stated they would indicate ADAS in “mechanical failures or contributing factors.” Another officer indicated they would indicate ADAS “only if an involved driver makes a statement about it,” but did not describe where in the form they would include the information. One officer said, “I only annotate if I feel it should or did play a part,” without describing how they would enter information into the form.

None of the six Iowa officers who were interviewed reported a past experience of indicating ADAS when completing a standard crash report. One reconstructionist estimated they had mentioned ADAS in their investigation reports less than five times in the last five years.

The interviews yielded similar information as the surveys, including the ideas that it was unnecessary to indicate ADAS in a report since it would not have affected the outcome of the crash and that a technical investigation would be needed to determine ADAS involvement. One officer said they routinely include driver statements in their crash reports, so they would indicate ADAS involvement if a driver mentioned ADAS in their statement. One interviewee thought they might consider automatic braking to be “evasive action” and indicate that in the report in the fields associated with Vehicle Action or the Sequence of Events and then explain the “evasive action” in the Narrative field. Another officer speculated that use of ADAS could fall under a Driver Contributing Circumstance (i.e., driver was not paying attention so ADAS activated) or a Vehicle Contributing Circumstance (i.e., if an ADAS that should be “on” at all times did not respond as expected).

Suggestions for Including ADAS Fields

The survey invited officers, “Imagine that the Iowa crash report form is being revised to include new fields for information related to ADAS technologies. Please describe your preference for the revisions, including the number and type of fields you would suggest.”

Most officers did not provide a response or indicated they did not have any recommendations (n=14, 38%). Six officers (10%) did not provide a suggestion for the crash report form, but pointed out that they did not have the knowledge to make the determination. They cited a need to be able to access data from the manufacturers or pull data from the vehicle. One noted, "Before revising the form, officers need the means to determine if ADAS are involved and in what way." One of the interviewed officers provided similar thoughts. "No. In fact, I would recommend they hold off [revising the form]… until the industry as standardized... whatever data you get is gonna be useless. The cars are different. The terminology is different. The [EDR] reports are different. The officers have been trained different."

Nine officers (14%) said they did not want the crash report form to be changed. Several said it was unnecessary because ADAS involvement does not change driver responsibility, applies to a small number of vehicles, and if ADAS were involved, it could be described in the narrative. Several also mentioned that additional fields will increase the time needed for officers to complete the report and for various reasons, officers will not take "the time to thoroughly collect the information." In addition to these nine officers, one other who did not explicitly say the form should not be changed noted their answer "would depend upon if the law recognizes a driver would not be responsible for a crash because of ADAS features." Yet another officer advocated for law enforcement experience in crash reporting to be involved in revising the crash report form.

Twenty officers (32%) provided suggestions about how to change the crash report. Several officers suggested having a checkbox to indicate whether the vehicle was equipped with ADAS followed by a dropdown list of systems. Some officers suggested using a similar approach to indicate which ADAS were being used or that was a factor in the crash. Other officers suggested having a field to indicate whether data was downloaded from the EDR.

Colorado Crash Report

Of the three survey respondents employed in Colorado, two provided information about how they indicate the presence of ADAS in the Colorado Traffic Crash Report. One described how the report has a section specific to report the automation level of the vehicle. The other officer indicated they use the CarFax form for Vehicle Automation but did not provide information about how the information is entered into the crash report. The third officer did not provide an answer.

The survey respondents from Colorado were asked to provide ratings of how much they agreed or disagreed with a series of questions about the crash report fields related to ADAS. One of these officers somewhat disagreed that they had received formal training about entering information into the Autonomous Vehicle Capability field, somewhat disagreed that the field was sufficient for reporting ADAS related information, somewhat agreed that the method of reporting ADAS-related information in the crash report should be improved, and had some level of disagreement about understanding all the levels of automation for the AV Capability field and the "Driver Ceded Control of Vehicle" field. The other two officers, who strongly and slightly agreed that they had received formal training, strongly and somewhat agreed that the AV Capability field was sufficient, and somewhat and slightly disagreed that the crash report needed to be improved. Both these officers strongly agreed that they understood when to indicate the Driver Ceded Control of Vehicle and mostly agreed that they understood the levels of automation. All three officers agreed that a new field should be added to the Colorado Traffic

Crash Report for the investigator to enter the type of ADAS technology or technologies on the vehicle.

The three interviewees employed in Colorado were asked whether they had received any instruction about how to include information about automation in the crash report. One officer said they received some information through the agency's online training system when the crash report changed and also knew that the crash manual was updated. The second officer said they had not received any training but had done a little bit of research on their own. The third officer said they had received "very limited" instruction about using the AV Capability field in the crash report and if they had a question they would have to reach out to a supervisor or a colleague who conducts higher-level crash investigations. The latter two officers both rated their understanding of the different levels of automation for the AV Capability field around two or three out of five.

None of the six officers from Colorado had suggestions for revisions to crash report form. However, three of them responded to that question that more training was needed. One of them did state, "I don't think the report needs to be changed but… I do feel training in ADAS vehicles is needed. This includes all law enforcement assigned to investigate and/or reconstruct crashes." Another provided, "there's a lot of people that don't have a lot of car knowledge. Just a little bit more of a descriptor as of, what each part does and how they will affect the vehicle when in motion."

ADAS Training

Officers provided details about previous ADAS training as it related to investigations and crash reporting as well as their preferences for future ADAS training.

Previous ADAS Training

A small number of officers indicated in their surveys that they had received either formal ADAS training or informal ADAS training. The two respondents who had reported formal training said it was provided by crash investigators or TI school. One officer said the training was slightly effective and they would have like additional information because the training only covered systems that used forward facing cameras. The other officer said their training covered a variety of ADAS features and was somewhat effective.

The three survey respondents who had received informal ADAS training or materials noted they were provided by a vehicle manufacturer, the National Highway Traffic Safety Administration, and the National Association of Professional Accident Reconstruction Specialists. All three of these respondents rated the information or training as very effective. The informal training topics included: ADAS, articles on Tesla vehicles and technology, and articles that covered lane departure warnings.

The only ADAS-related training identified in the interviews was specific to technical investigators or crash reconstructionist. The training topics included awareness of ADAS and how to do data downloads. At least one officer mentioned their experience with ADAS in their personal vehicles as another way of learning about ADAS. One Colorado officer stated they had received "very limited" information about ADAS but was not sure where they had learned it from. The other two Colorado officers said they had done some research and had searched online to learn more about ADAS.

ADAS Training Preferences

Officers who completed the survey were invited to rate their level of agreement with two statements about training about ADAS. The results are shown in Figure 5. About 86% of the officers agreed to some degree that their ability to effectively investigate crashes would be enhanced if they received training about ADAS. More than 80% of officers said they would like training about ADAS. The most effective way to learn about ADAS identified was through an in-person class. Thirty-five indicated an in-person class alone and another eight identified including an in-person class in combination with another method. Using printed materials was only identified once alone, however was included in combination five times.

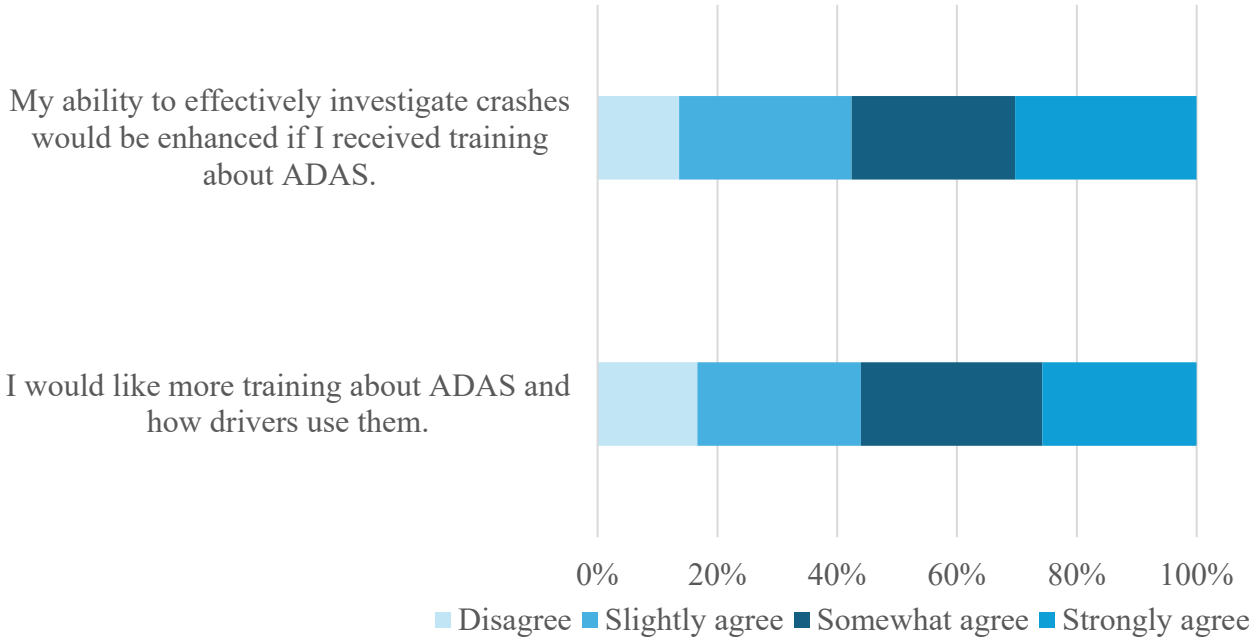


Figure 5. Officers' level of understanding, with consideration of its purpose, function, and limitations, for each ADAS.

Table 18. Officer training method type preferences from survey

Training method	***n***	**%**
In-person class	35	53
Online module	8	12
Pre-recorded videos	7	11
Virtual class	4	6
Printed materials	1	2
Combination	8	12
Prefer not to answer	3	5

The officers who were interviewed were also asked to provide their thoughts on ADAS training, including training methods, duration of training and topics that should be included.

Like the officers who completed the survey, the interviewees preferred in-person experiences and felt they would be most effective for learning, especially if the training included demonstrations or the opportunity to experience ADAS in action. However, they also acknowledged the barriers to sending officers to classes or conferences. One said, “It is probably more cost effective to do some kind of online thing.” Another said that sending out information by email was ineffective. One officer from Iowa referenced a YouTube training video that had been produced for officers and said that it was not very effective because only the officers who cared about the accuracy of their crash reports watched and paid attention to what it said. That officer thought a virtual meeting could be effective as long as people “are willing to listen and not play games on their phone while they are supposed to be learning.” In an online environment, most officers suggested keeping the training to less than 30 minutes.

As for training topics, most of the officers suggested keeping the training “broad and general” with a high-level description of each type of ADAS, what the systems’ capabilities are, and how they can affect a crash. One of the officers suggested providing “generic” questions officers could ask drivers. Another officer suggested providing information to officers about how to find out what technologies are included on a vehicle. Another suggested topic was to explain the difference between ADAS and automated driving. One officer suggested having review or test questions.

Two officers said that learning about the technology in vehicles and including it in crash reports would only get more important as the systems became more automated and were present in more cars. One said, “I think a lot of the troopers just either assume if it's not an auto drive or it's not a Tesla, then it's not automated.”

ADAS Personal Use

Fifty-nine officers (89%) who completed the survey reported that at least one vehicle they drive regularly for work or personal use has at least one ADAS feature, as shown in Table 19. A much greater proportion of officers reported having ADAS on a personal vehicle than on a vehicle they drive regularly for work. The one exception to this pattern was blind spot warning, with 56% of all officers who completed the survey reporting having this ADAS on a vehicle they drive for work. Another 22 officers (33%) reported having BSW on a personal vehicle, which totals 89% of the officers. At least half the officers reported having lane departure warning (50%) and forward collision warning (53%) on a personal vehicle.

Table 19. Officer's survey responses about ADAS-equipped vehicles they drive regularly

	Personal	Work	Both	Total
BSW	22	8	29	59
LDW	33	2	1	36
FCW	35	4	2	41
AEB	26	3	3	32
AES	18	2	0	20
LKA	29	2	1	32
ACC	27	1	4	32
LCA	22	2	1	25
ADA	11	1	0	12

Discussion

Nearly all the officers who completed the survey do not consider ADAS as a routine part of their crash investigations. Officers cited a lack of training and awareness about ADAS or not having the training or equipment to download event data recorder (EDR) data from vehicles. Some officers cited probable cause and the need to get data that would "prove" that the ADAS did or did not do something during the crash. Multiple officers were skeptical that asking drivers about the ADAS on the vehicle would yield useful information. Officers also said considering ADAS was unnecessary because ultimately the driver is still responsible for the crash.

Officers who had considered ADAS during an investigation said they had done so because the driver made a statement about ADAS or the officer had noted that the vehicle was relatively new. Fifteen of the surveyed officers indicated they had obtained EDR data to determine ADAS status at the time of the crash. The interviews revealed several challenges officers face when they try to retrieve and interpret EDR data, including expensive equipment and software and a lack of standardization for which ADAS parameters and data sources need to be recorded across different manufacturers.

Collectively the officers identified multiple cases where automatic braking had mitigated crashes as well as several crashes where a vehicle activated AEB and avoided the frontal collision but was struck from behind by another vehicle. Other crashes involved drivers over-relying on blind spot warning and lane assistance features.

Thirty percent of the officers said if they needed to indicate ADAS in the Iowa crash report form they would do so in the Narrative field. Several officers who completed the survey made the point that they do not have the knowledge needed to make a determination about ADAS involvement. Many officers cautioned against making changes to the crash report form until it is easy and efficient for officers to obtain standardized information about ADAS from vehicles and manufacturers.

Only five officers who completed the survey said they had received any training about ADAS. The majority, if not all, the officers who had learned about ADAS had advanced training in conducting investigations (i.e., technical accident investigation or crash reconstruction). Well over 80% of the officers who completed the survey agreed they wanted to receive training about ADAS and how drivers use them. The officers expressed a preference for receiving training in-person.

Despite the lack of formal or informal ADAS training, many officers rated their level of understanding for various ADAS as high, especially for the three types of collision warnings and adaptive cruise control. These were also the most common ADAS reported by the motorists in this study. Most officers agreed at some level that they knew where on a vehicle to look for ADAS sensors and cameras. Most officers also agreed that they understood the difference between ADAS and automated driving systems. However, at least six of the officers who were interviewed gave responses that indicated that they considered Teslas to be autonomous vehicles.

Recruiting officers to participate in this study was challenging. The researchers were limited to recruiting officers through their agencies and associations, which resulted in over-representation of officers employed by the state patrol with advanced training in crash investigations. Therefore, the responses of the participants in this study cannot be generalized to the whole population of law enforcement officers who investigate crashes.

RECOMMENDATIONS

The findings from this project inform several recommendations for different stakeholders, including departments of transportation and infrastructure owners/operators, law enforcement, crash reporting agencies, and vehicle manufacturers and dealerships.

Standardization

The theme of standardization came up many times during this project, including standardization of ADAS names and functionality across vehicles of different makes and models, standardization of ADAS information, education and training given to those who buy vehicles with ADAS, standardization of which ADAS parameters and data sources need to be recorded by EDRs across different manufacturers, standardization of tools for reading EDR data, and methods for officers to visually ascertain whether ADAS are involved in a crash (e.g., a light that illuminates on the dash for 30 minutes after automatic braking has occurred). Developing standards requires the work of stakeholders across many different areas of government and industry.

Departments of Transportation and Infrastructure Owner/Operators

Organizations responsible for designing, implementing, and maintaining infrastructure need to be aware of what information ADAS sensors use and how their operation can be impacted by roadway and environmental conditions.

Consider messaging to motor vehicle operators who are entering work zones to turn off driving control assistance features and maintain control of their vehicles at all times. Warn drivers that pavement markings are not present or are in poor condition.

Improve lane markings, including widening lines, increasing contrast with respect to the road surface, continuing edge lines through ramp areas and intersections, and leaving space between the lane line and the pavement edge so lane keeping support systems can respond before a tire drops off the hard surface.

Plan for the clean removal of temporary lane lines after construction and maintenance projects have ended.

Make sure road signs, including speed limit signs, are kept in good condition and quickly repaired or replaced when damaged.

Departments of Motor Vehicles

Divisions responsible for the registration of motor vehicles should consider enhancing data systems to capture information about the ADAS a vehicle is equipped with when it is first registered. In this way, law enforcement officers and others can readily access the information if needed during a traffic stop or crash investigation and lay the foundation for the vehicle's ADAS information to automatically be pulled into the electronic crash report in the future.

Divisions responsible for driver licensing should consider augmenting driver education to include content about ADAS and providing information about ADAS to all drivers. For example, educating all motorists about how automatic emergency braking works and how quickly it can stop the vehicle that one is traveling behind might motivate some drivers to increase their

following distance. A visual plot of a human braking profile compared to one from an AEB system might be an effective teaching aid.

Law Enforcement

Law enforcement agencies and academies can begin planning ways to provide officers with ADAS education and training. The content should include general information about what ADAS are, what they do, and how they work, including the sensors and cameras. It could also include guidance for officers about what types of ADAS can play a role in different types of crashes. The guidance can focus on things the officer can observe on the outside of the vehicle and questions they can ask the driver that are relevant for the given circumstances of the crash or traffic stop. Any statement that the driver makes can be noted in the Narrative of the crash report (if applicable).

Many officers indicated they prefer hands-on learning. Encourage officers who do not have first-hand experience with different types of ADAS to try them out. An agency could work with a local dealership to give officers the chance to test drive different vehicles. Officers could borrow a vehicle from a friend or family member.

Two officers who participated in this study mentioned CARFAX for Police as a source of information about the advanced technologies on a vehicle. The researchers were not able to independently verify this option, but it is one that law enforcement officers or agencies could investigate.

Crash Reporting

Multiple officers from Iowa who participated in this study would not recommend changing the Iowa Crash Report to add fields for ADAS information unless there is a fast and easy way for them to determine which ADAS are on the vehicle and which ones were active during the crash. If or when the time comes to make updates to the crash report form (for any reason), officers who complete crash reports need to have a seat at the table and be involved in the process.

Officers can be coached to consider ADAS during a crash investigation without having to obtain EDR data, just as they assess restraint use without getting seat belt data from the EDR. If a motorist claims an ADAS malfunctioned or did not do what they expected it to, an officer can include the driver's statement in the narrative of the report without having to make a judgment as to the accuracy of the statement. In a rear-end crash, the officer could simply ask both drivers whether they know if their vehicle has any type of automatic braking and record their answers.

The crash report in Colorado includes two fields related to ADAS and levels of automation. Through the survey and interviews, the six officers from Colorado exhibited some uncertainty about which level of automation would be appropriate to code and whether it should be related to highest level of automation available on the vehicle or the level of automation that was active during the crash.

Vehicle Manufacturers

There are three main areas where manufacturers can make improvements to ADAS: documentation and data recording, consumer education, and system design.

One major obstacle for vehicle owners and officers is being able to know with a high level of confidence which technologies a vehicle is equipped with. Publicly available VIN decoders often return inaccurate information. Manufacturers could implement systems that would make it easy for anyone, including officers, to scan or enter the VIN and see exactly how the vehicle was equipped. Manufacturers could go a step further and provide consumers with a customized owner's manual that includes only the information that is relevant for the systems on the specific vehicle.

Another obstacle is obtaining and interpreting data from the ADAS systems on the vehicle. Manufacturers need to record and retain data about ADAS activations so mechanics can diagnose and address system malfunctions, and crash investigators can obtain the data to assess whether the ADAS had an impact on the crash.

Consumer education is another area where manufacturers could make great strides toward the safer use of ADAS. Vehicle companies need to provide their customers with accurate and engaging materials that use plain language and visuals to educate them about the specific systems on their vehicles. Branded dealerships should standardize how information is shared with customers, including developing ADAS demonstration protocols, and ensuring that education is part of the purchase experience.

Finally, manufacturers can consider these design recommendations from the motorists who participated in this study. They include

- Supporting lane assistance features when only one lane marking is detected
- Giving lane assistance feedback through a modality that does not "shake" the steering wheel
- Allowing users of lane centering assistance systems to make adjustments for their preferred lane position
- Decoupling lane centering assistance from cruise control
- Allowing users of adaptive cruise control to customize acceleration rates
- Consider sensors that are more robust to ice, snow, dirt and moving debris and give operators the option to temporarily silence the notifications without having to stop the vehicle.

CONCLUSION

Advanced Driver Assistance Systems are prevalent in the current fleet of passenger and commercial vehicles. The data collected from this study provides evidence that ADAS can both prevent or mitigate crashes and contribute to crashes and near-crashes. Motorists and officers have a range of understanding about ADAS. When motorists are unaware of, misunderstand or over-rely on the technologies in their vehicles, their knowledge gaps have the potential to increase crash risk. Improving the quality of information and education given to consumers before, during and after the purchase of their vehicles could be beneficial.

Very few crash investigations consider ADAS or include ADAS information in the report. Most officers who have investigated ADAS have received advanced training in crash investigations. The vast majority of the law enforcement officers who participated in this study indicated a desire to learn more about ADAS to enhance their ability to investigate crashes.

REFERENCES

1. Bartlett, J. S. (2021, November 4). How much automation does your car really have? Consumer Reports. https://www.consumerreports.org/automotive-technology/how-much-automation-does-your-car-really-have-level-2-a3543419955/. Retrieved August 23, 2022.
2. Cicchino J. B. (2018). Effects of lane departure warning on police-reported crash rates. Journal of Safety Research, 66, 61–70.
3. DeGuzman, C. A., & Donmez, B. (2021). Drivers Still Have Limited Knowledge About Adaptive Cruise Control Even When They Own the System. Transportation Research Record, 2675(10), 328–339.
4. Fildes, B., Keall, M., Bos, N., Lie, A., Page, Y., Pastor, C., Pennisi, L., Rizzi, M., Thomas, P. & Tingvall, C. (2015). Effectiveness of low speed autonomous emergency braking in real-world rear-end crashes. Accident Analysis & Prevention, 81, 24–29.
5. Gaspar, J., Carney, C., Shull, E., & Horrey, W. (2020). The Impact of Driver's Mental Models of Advanced Vehicle Technologies on Safety and Performance. (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety.
6. Harms, I. M., Bingen, L., & Steffens, J. (2020). Addressing the awareness gap: A combined survey and vehicle registration analysis to assess car owners' usage of ADAS in fleets. Transportation Research Part A: Policy and Practice, 134, 65-77.
7. Harris, P.A., Taylor, R., Thielke, R., Payne, J., Gonzalez, N., and Conde, J.G. (2009). Research electronic data capture (REDCap) - A metadata-driven methodology and workflow process for providing translational research informatics support, J Biomed Inform. 42(2): 377-81.
8. McDonald, A., Carney, C., & McGehee, D. V. (2018). Vehicle Owners' Experiences with and Reactions to Advanced Driver Assistance Systems. (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety.
9. National Highway Traffic Safety Administration. (2020, December 17). NHTSA Announces 2020 Update on AEB Installation by 20 Automakers. https://www.nhtsa.gov/press-releases/nhtsa-announces-2020-update-aeb-installation-20-automakers. Retrieved August 23. 2022.
10. Nylen, A. B., Reyes, M. L., Roe, C. A., & McGehee, D. V. (2019). Impacts on Driver Perceptions in Initial Exposure to ADAS Technologies. Transportation Research Record, 2673(10), 354–360.
11. Reagan, I. J. & McCartt, A. T. (2016). Observed activation status of lane departure warning and forward collision warning of Honda vehicles at dealership service centers. Traffic Injury Prevention, 17(8), 827–832.
12. Reyes, M. L., Roe, C. A., McDonald, A. B., Friberg, J. E., & McGehee, D. V. (2017). Adaptive Cruise Control: First Impressions Matter. SAE Technical Paper 2017-01-1382, doi: 10.4271/2017-01-1382.

13. Singer, J. & Jenness, J. (2020). Impact of Information on Consumer Understanding of a Partially Automated Driving System. (Technical Report). Washington, D.C.: AAA Foundation for Traffic Safety.

APPENDIX A.1. MOTORIST RECRUITMENT EMAIL

FOR IRB USE ONLY
APPROVED BY: IRB-02
IRB ID #: 202211307
APPROVAL DATE: 07/06/23

Subject: Participants invited to complete survey

Are you interested in participating in a research study?

The University of Iowa Driving Safety Research Institute (DSRI) is inviting adult drivers to complete a survey as part of a research study. The purpose of the study is to gather information from motorists who were operating a passenger vehicle equipped with advanced technology that was involved in a crash or near-crash in the last 12 months.

Some volunteers who complete the survey will be invited to participate in an optional virtual interview about their crash. This will take up to 1.5 hours to complete.

Who can be part of this study?

- Adults aged 18 +
- Drivers who were operating a passenger vehicle on a roadway that was involved in a crash or near-crash in the last 12 months. (A near-crash is defined as anytime you or another person took evasive action to avoid a collision with another vehicle or object, not including animals.)
- The passenger vehicle involved in the crash or near-crash had at least one advanced technology (i.e., Adaptive Cruise Control, Automated Emergency Braking, Forward Collision Warning, Lane Departure Warning, Lane Keeping Assist, Lane Centering Assist, Blind Spot Warning, etc.)

If you meet the above criteria and are interested in participating, please visit the following link for more information and to complete the online survey: https://redcap.link/crash_tech1. You are encouraged to forward this email to individuals you know who may be eligible for participation.

If you have any questions or concerns at any time, please feel free to email us at dsri-recruit@uiowa.edu. Please reference "Crash Tech" when emailing.

There is no compensation for completing the survey.

APPENDIX A.2. MOTORIST SOCIAL MEDIA POST

Iowa social media text with image

DSRI is looking for individuals to complete a survey: redcap.link/crash_tech1. Share with others who might be eligible.

Colorado social media text with image

Have you been in a crash or near-crash the last year? Was the vehicle equipped with an advanced safety technology? If so, researchers would like to hear about your experience. CDOT is partnering with the Iowa Department of Transportation and the Driving Safety Research Institute at the University of Iowa to learn more about crash situations involving advanced driver assistance systems. Take the survey at redcap.link/crash_tech1 and share the link with others who might be eligible.

Image

APPENDIX A.3. IOWA DOT RECRUITMENT LETTER

Hello!

You are receiving this letter because you may be eligible for a research study being conducted by the Driving Safety Research Institute (DSRI) at the University of Iowa. The Iowa Department of Transportation (DOT) is one of the agencies that is co-sponsoring the study.

The purpose of the study is to learn more about crash situations involving advanced vehicle technologies. If you meet the criteria below, please consider learning more about the study by following the instructions on the enclosed card.

Who can be part of this study?

- Adults aged 18 +
- Drivers who were operating a passenger vehicle on a roadway that was involved in a crash or near-crash in the last 12 months. (A near-crash is defined as anytime you or another person took evasive action to avoid a collision with another vehicle or object, not including animals.)
- The passenger vehicle involved in the crash or near-crash had at least one advanced technology, for example, Adaptive Cruise Control, Automated Emergency Braking, Forward Collision Warning, Lane Departure Warning, Lane Keeping Assist, Lane Centering Assist, Blind Spot Warning, etc.

Your identity and contact information **have not** been shared with the DSRI research team. If you decide to participate in the study, your participation will be confidential, and your identity **will not** be disclosed to the Iowa DOT.

If you have any questions about the study itself, please email dsri-recruit@uiowa.edu and reference “Crash Tech” in the subject line. If you have questions about why you received this mailing, you can email me at Andrew.Lewis@iowadot.us.

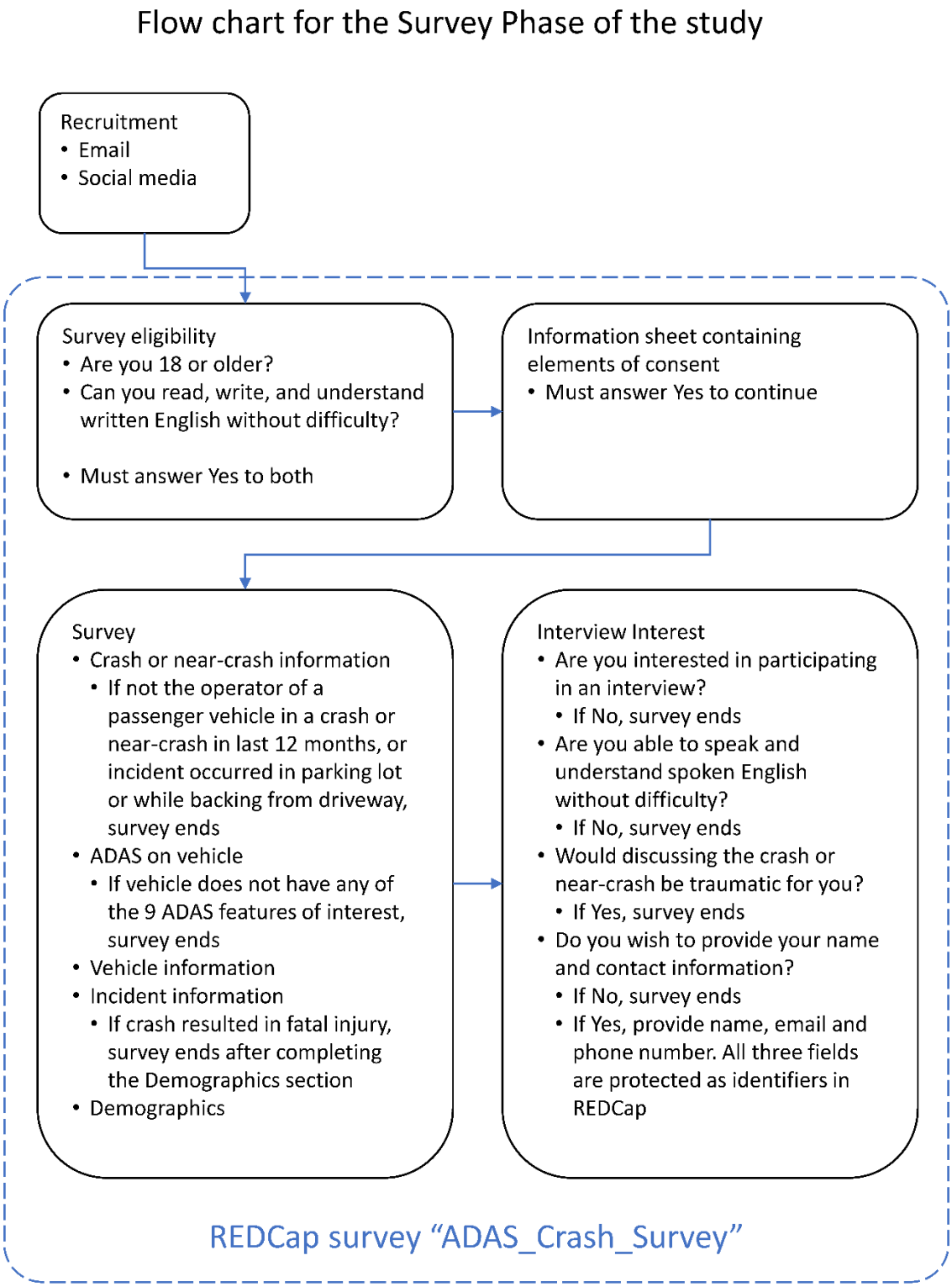
Sincerely,

Andrew P. Lewis

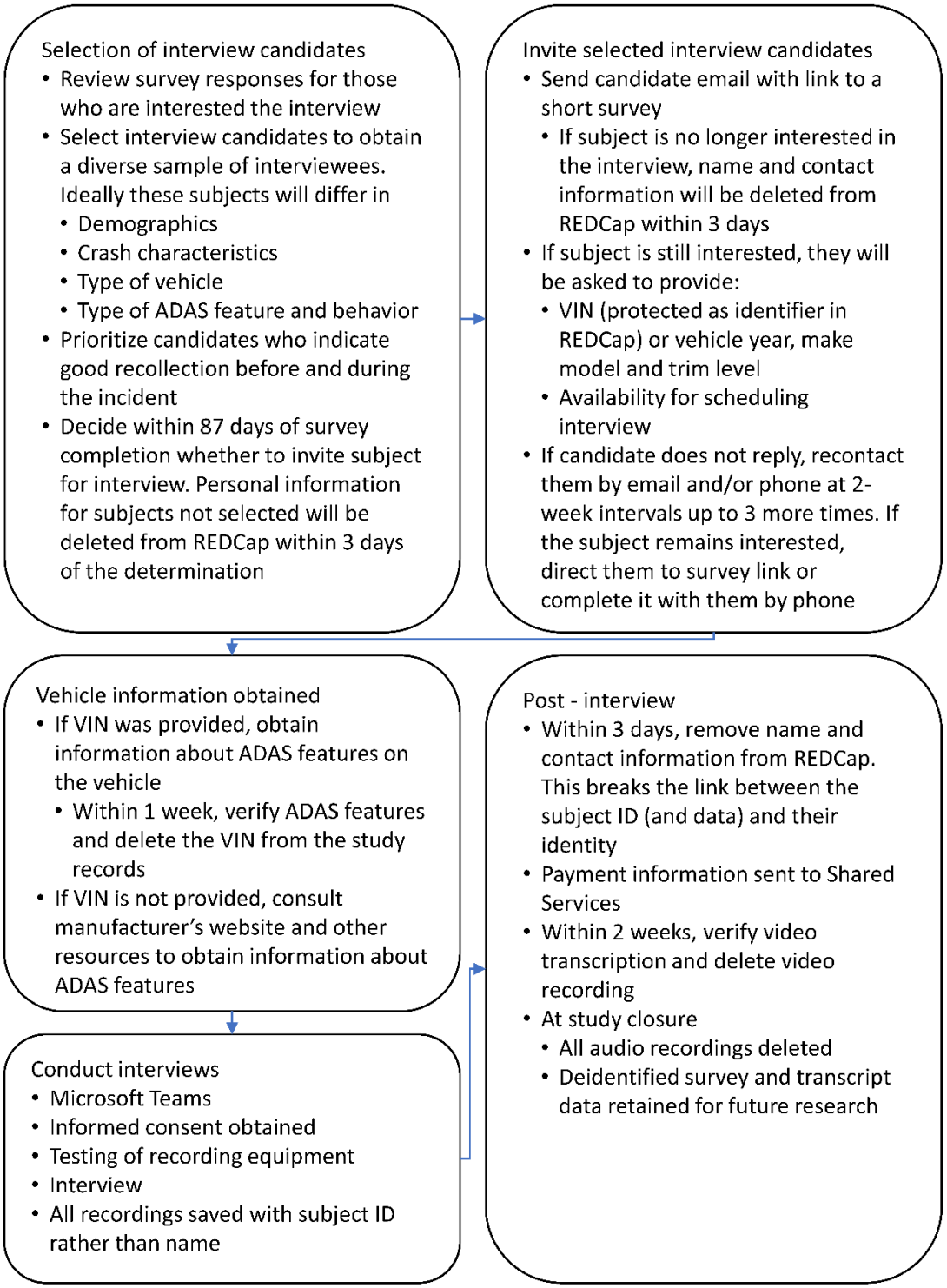
Andrew Lewis
Director, Traffic Operations Bureau

APPENDIX A.4. MOTORIST RECRUITMENT POSTCARD

APPENDIX A.5. MOTORIST FLOW CHARTS



Flow chart for the Interview Phase of the study



APPENDIX B. MOTORIST SURVEY

Thank you for your interest in our study gathering information from motorists about crashes and near-crashes.

This research study is being conducted by investigators from the University of Iowa Driving Safety Research Institute. The purpose of the study is to gather information from motorists about real-world crashes and near- crashes that involve vehicles equipped with advanced technologies. The study will be conducted in two phases: a survey and an optional interview. You must be 18 or older to participate.

Are you age 18 or older? (If you select "yes", you will need to click "Next Page" on the following page to continue to information about the study.)

* must provide value

◯ Yes ◯ No

Can you read, write, and understand written English without difficulty?

* must provide value

◯ Yes ◯ No

Survey Consent

Project Title: An Investigation of the Factors Surrounding Crashes of ADAS-Equipped Vehicles

Principal Investigator: Michelle Reyes, 319-335-9563

We invite you to participate in a research study being conducted by investigators from the University of Iowa Driving Safety Research Institute. The purpose of the study is to gather information from motorists about real-world crashes and near-crashes that involve vehicles equipped with advanced technologies. The study will be conducted in two phases: a survey and an optional interview.

We are inviting you to be in this study if you were the operator of a passenger vehicle involved in a crash or near-crash on a roadway in the last 12 months and the passenger vehicle involved in the crash or near-crash was equipped with at least one advanced technology. Although the number of people who will take part in the survey phase of this study is unknown, no more than 30 participants will participate in the interview phase.

If you agree to participate in the survey phase of the study, we would like you to complete the following online survey. You will be asked to provide information about the incident (e.g., type of crash/near-crash, when and where it occurred, weather and road conditions), information about the vehicle you were operating at the time of the crash/near-crash (year, make, model, advanced technologies), the behavior of the advanced technologies during the incident, and demographic information. You are allowed to indicate "Prefer not to answer" for any questions that you want to skip. Completing the survey will take approximately 15 to 20 minutes.

At the completion of the survey, you may be asked if you would like to be considered for the interview phase. If you are not interested in participating in the interview, there will be no personal link to your survey responses. If you would like to be considered for the interview phase, we will ask you a few more questions to determine your eligibility for the interview and collect your name and contact information. Only some of those who provide contact information will be invited for an interview. Providing your personal information will link your identity to your survey responses. If you provide your name and contact information, the research team has up to 90 days to invite you to participate in an interview. If you are not invited to participate in the interview, or you decline the invitation, your name and contact information will be deleted from the study's secure data management system. Indicating interest in the interview does not obligate you to participate if you are invited.

You may experience some anxiety and/or discomfort because you will be asked to provide information about a motor vehicle crash or near-crash. Loss of confidentiality is always considered a risk.

We will keep your participation in this research study confidential to the extent permitted by law. However, federal regulatory agencies and the University of Iowa Institutional Review Board (a committee that reviews and approves research studies) may inspect and copy records pertaining to this research. Under extreme and extraordinary circumstances (i.e., subpoena for study records) and under advisement from the General Counsel, law enforcement may be provided information that includes your identity.

To help protect your confidentiality, we will assign you a unique code that will be used instead of your name to identify all data collected for the study. The list linking your unique code and your name (if you choose to provide it) will be stored in a secure location and will be accessible only to the researchers at the University of Iowa. All records and data containing confidential information will be maintained in locked offices or on secure password-protected computer systems that are accessible to the researchers. If we write a report about this study, we will do so in such a way that you cannot be identified.

Your de-identified survey data (that is, data without your name) will also be retained for use in future research studies, after this study is over. Other qualified researchers who obtain proper permission may gain access to your de-identified data for use in approved research studies that may or may not be related to in the purpose of this study. These future studies may provide additional information that will be helpful in understanding crashes involving advanced vehicle technologies, but it is unlikely that what we learn from these studies will have a direct benefit to you. Providing data through this survey means your de-identified data will be available for use in future research studies indefinitely.

You will not benefit personally from being in this study. However, we hope that others may benefit in the future from what we learn as a result of this study.

You will not have any costs for being in this research study.

You will not be paid for being in the survey phase of this research study.

Taking part in this research study is completely voluntary. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized or lose any benefits for which you otherwise qualify.

If you have any questions or problems with completing the survey, please contact Cheryl Roe at the University of Iowa at 319-335-6803 or by email at cheryl-roe@uiowa.edu. If you have questions about the rights of research subjects, please contact the Human Subjects Office, 105 Hardin Library

for the Health Services, 600 Newton Rd, The University of Iowa, Iowa City, IA 52242-1098, (319) 335-6564 or email irb@uiowa.edu. To offer input about your experience as a research subject or to speak to someone other than the research staff, call the Human Subjects Office at the number above.

Thank you very much for your consideration. Are you interested in completing the survey? By selecting "Yes," you are consenting to provide us with information. Researchers will have access to this data.

* must provide value

◯ Yes ◯ No

Thank you for your interest in our study! How did you hear about the study?

* must provide value

- ☐ Email
- ☐ Social Media (Facebook, Twitter
- ☐ Letter in the Mail
- ☐ Website
- ☐ Word of mouth
- ☐ Other
- ☐ Prefer not to answer

ADAS Eligibility

In the last 12 months, were you the operator of a passenger vehicle that was involved in a crash? A crash is defined as a collision with another vehicle, departing the road, or striking an object other than an animal.

* must provide value

◯ Yes ◯ No

In the last 12 months, were you the operator of a passenger vehicle that was involved in a near-crash?

A near-crash is defined as a time you or another person took evasive action to avoid a collision with another vehicle or object (not including an animal) or to avoid a road departure.

* must provide value

◯ Yes ◯ No

Where did this incident (i.e., the crash or near-crash) occur?

* must provide value

- ◯ On a public roadway or street
- ◯ In a parking lot
- ◯ While backing from a driveway
- ◯ Other

Advanced Vehicle Technologies

Many vehicles are equipped with systems designed to assist the driver. These systems are often referred to as Advanced Driver Assistance Systems (ADAS). These systems monitor the driving environment and may warn you of potential collisions, provide intervention during potential collisions, or may provide driving control assistance.

The following questions list different types of ADAS with descriptions of their functions. The actual name of the system on any given vehicle will likely differ since vehicle manufacturers commonly give their systems proprietary names. Please select the best answer for the vehicle you were operating at the time of the incident.

The following systems provide some kind of driving control assistance. Please read each description and select the option that best describes the presence of each system and its use at the time of the incident.

Adaptive Cruise Control
Cruise control that also assists with acceleration and/or braking to maintain a driver-selected gap to the vehicle in front. Some systems can come to a stop and continue while others cannot. It is possible that the system on your vehicle may refer to this as a different name.

- ○ The vehicle had this system and I am confident it was active at the time of the incident.
- ○ The vehicle had this system but I am not sure if it was active at the time of the incident.
- ○ The vehicle had this system and I am confident it was not active at the time of the incident.
- ○ The vehicle did not have this system.
- ○ I don't know if the vehicle had this system.
- ○ Prefer not to answer

Lane Centering Assistance
Provides steering support to assist the driver in continuously maintaining the vehicle at or near the center of the lane.

- ○ The vehicle had this system and I am confident it was active at the time of the incident.
- ○ The vehicle had this system but I am not sure if it was active at the time of the incident.
- ○ The vehicle had this system and I am confident it was not active at the time of the incident.
- ○ The vehicle did not have this system.
- ○ I don't know if the vehicle had this system.
- ○ Prefer not to answer

Active Driving Assistance
Simultaneous use of Lane Centering Assistance and Adaptive Cruise Control features. The driver must constantly supervise this support feature and maintain responsibility for driving.

- ○ The vehicle had this system and I am confident it was active at the time of the incident.
- ○ The vehicle had this system but I am not sure if it was active at the time of the incident.
- ○ The vehicle had this system and I am confident it was not active at the time of the incident.
- ○ The vehicle did not have this system.
- ○ I don't know if the vehicle had this system.
- ○ Prefer not to answer

The following systems provide some kind of intervention when a potential collision or lane departure is detected. Please read each description and select the option that best describes the presence of each system and its use at the time of the incident.

Automatic Emergency Braking
Detects potential collisions with a vehicle ahead, provides forward collision warning, and automatically brakes to avoid a collision or lessen the severity of impact. Some systems also detect pedestrians or other objects.

- ○ The vehicle had this system and I am confident that it intervened during the incident.
- ○ The vehicle had this system but I am not sure if it intervened during the incident.
- ○ The vehicle had this system and I am confident it did not intervene during the incident.
- ○ The vehicle did not have this system.
- ○ I don't know if the vehicle had this system.
- ○ Prefer not to answer

Automatic Emergency Steering
Detects potential collisions with a vehicle ahead and automatically steers to avoid or lessen the severity of impact. Some systems also detect pedestrians or other objects.

- ○ The vehicle had this system and I am confident that it intervened during the incident.
- ○ The vehicle had this system but I am not sure if it intervened during the incident.
- ○ The vehicle had this system and I am confident it did not intervene during the incident.
- ○ The vehicle did not have this system.
- ○ I don't know if the vehicle had this system.
- ○ Prefer not to answer

Lane Keeping Assistance
Provides steering support to assist the driver in keeping the vehicle in the lane. The system reacts only when the vehicle approaches or crosses a lane line or road edge.

- ○ The vehicle had this system and I am confident that it intervened during the incident.
- ○ The vehicle had this system but I am not sure if it intervened during the incident.
- ○ The vehicle had this system and I am confident it did not intervene during the incident.
- ○ The vehicle did not have this system.
- ○ I don't know if the vehicle had this system.
- ○ Prefer not to answer

The following systems provide some kind of warning when a potential collision is detected. Please read each description and select the option that best describes the presence of each system and its use at the time of the incident.

Blind Spot Warning
Detects vehicles in the blind spot while driving and notifies the driver to their presence. Some systems provide an additional warning if the driver activates the turn signal.

- ○ The vehicle had this system and I am confident it issued a warning during the incident.
- ○ The vehicle had this system enabled at the time of the incident but I am not sure if it issued a warning.
- ○ The vehicle had this system enabled at the time of the incident and I am confident it did not issue a warning.
- ○ The vehicle had this system but I'm not sure if it was enabled at the time of the incident.
- ○ The vehicle had this system but it was disabled at the time of the incident.
- ○ The vehicle did not have this system.
- ○ I don't know if the vehicle had this system.
- ○ Prefer not to answer

Forward Collision Warning
Detects a potential collision with a vehicle ahead and alerts the driver. Some systems also provide alerts for pedestrians or other objects.

- ○ The vehicle had this system and I am confident it issued a warning during the incident.
- ○ The vehicle had this system enabled at the time of the incident but I am not sure if it issued a warning.
- ○ The vehicle had this system enabled at the time of the incident and I am confident it did not issue a warning.
- ○ The vehicle had this system but I'm not sure if it was enabled at the time of the incident.
- ○ The vehicle had this system but it was disabled at the time of the incident.
- ○ The vehicle did not have this system.
- ○ I don't know if the vehicle had this system.
- ○ Prefer not to answer

Lane Departure Warning
Monitors vehicle's position within the driving lane and alerts driver as the vehicle approaches or crosses lane markers.

- ○ The vehicle had this system and I am confident it issued a warning during the incident.
- ○ The vehicle had this system enabled at the time of the incident but I am not sure if it issued a warning.
- ○ The vehicle had this system enabled at the time of the incident and I am confident it did not issue a warning.
- ○ The vehicle had this system but I'm not sure if it was enabled at the time of the incident.
- ○ The vehicle had this system but it was disabled at the time of the incident.
- ○ The vehicle did not have this system.
- ○ I don't know if the vehicle had this system.
- ○ Prefer not to answer

Information about the Incident You Experienced

This section of the survey will ask you to provide some information about the crash or near-crash in which the vehicle you were operating was involved.

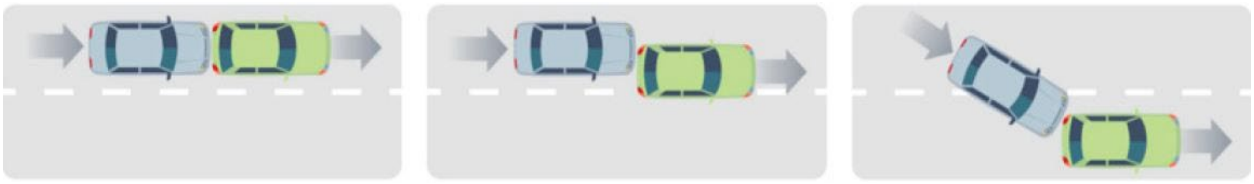
As a reminder, select or enter "Prefer not to answer" for any questions that you want to skip.

Please select the option below that best describes the type of crash you experienced or the type of near-crash you believe you would have experienced if evasive action was not taken.

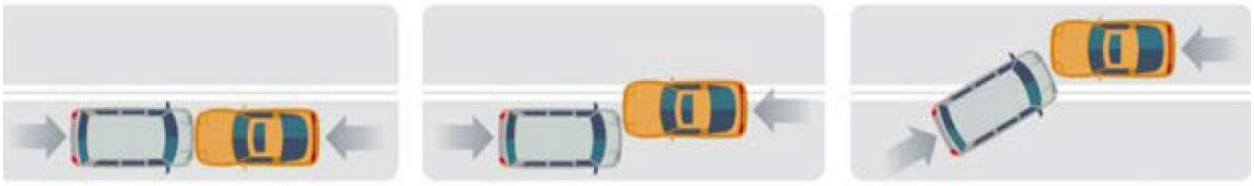
* must provide value

○ No vehicle involved - If your vehicle left the roadway and/or made contact with a fixed object, a non-motorist, or an animal before coming into contact with another vehicle or never made contact with another vehicle.

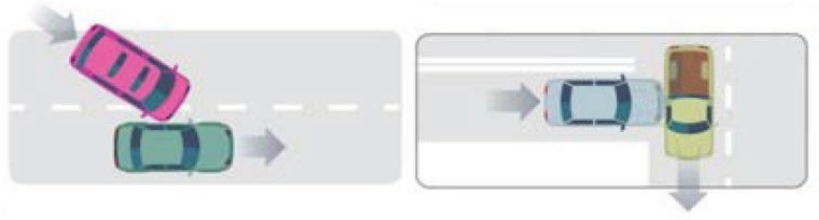
○ Front to Rear



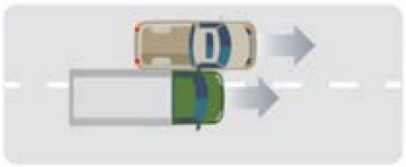
○ Front to Front



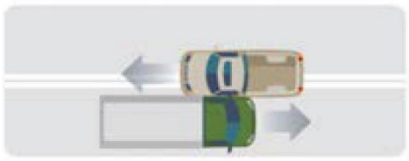
○ Front to Side



○ Sideswipe - Same Direction

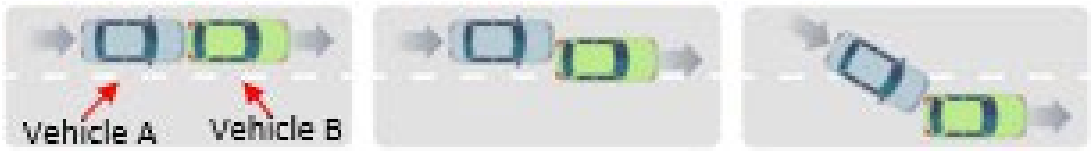


○ Sideswipe - Opposite Direction



○ Other _____
○ Prefer not to answer

You indicated a "Front to Rear." Please look at the illustrations below. In the incident you experienced, which vehicle best represented the vehicle you were operating?



* must provide value

○ Vehicle A (blue car)
○ Vehicle B (green car)
○ Prefer not to answer

Please provide the information for when and where the incident occurred. If you are unsure, please answer with your best guess.

Month	Year	State

Describe how the incident unfolded, including what was happening before the hazard or danger was apparent, how you noticed that something was wrong, what action you and/or others took, and what the outcome was.

To protect your confidentiality, please do <u>not</u> include identifying details, such as names of people involved in the incident or the specific location, date and time of the incident.

* must provide value

Vehicle Information

This section asks you to provide information about the vehicle you were operating at the time of the incident.

Did you or someone in your household own/lease the vehicle?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

If "No" is selected...

Who owned the vehicle?

* must provide value

- ○ Rental car company
- ○ Work vehicle
- ○ Borrowed from a friend or family member
- ○ Other _____
- ○ Prefer not to answer

Please provide the following information about the vehicle. If you are unsure, please select your best guess or unknown.

Year	Make	Model

Vehicle Technologies during the Incident

(Note: Subjects were asked questions about one ADAS which researchers intended to be the system that would provide the most assistance during the incident. The name of the ADAS was entered in each question.)

This section asks you to provide information about the behavior of the vehicle technologies during the crash or near- crash.

Do you think [ADAS] being active during the incident affected the outcome?

* must provide value

- ○ It made the outcome a lot worse
- ○ It made the outcome somewhat worse
- ○ It had no impact on the outcome
- ○ It made the outcome somewhat better
- ○ It made the outcome a lot better
- ○ Prefer not to answer

Did the [ADAS] behave as you expected at the time of the incident?

* must provide value

- ○ Yes
- ○ No
- ○ I don't know
- ○ Prefer not to answer

Please describe the behavior of the [ADAS] leading up to and during the incident.

Please describe the behavior you expected from the [ADAS] during the incident.

If [ADAS] had been active during the incident, do you think it could have affected the outcome?

(Note: only asked if subject said system was "not active" or they were "unsure.")

* must provide value

- ○ It would have made the outcome a lot worse
- ○ It would have made the outcome somewhat worse
- ○ It would have had no impact on the outcome
- ○ It would have made the outcome somewhat better
- ○ It would have made the outcome a lot better
- ○ Prefer not to answer

Please explain how [ADAS] would have affected the outcome.

Typical Driving with Advanced Technologies

This section of the survey asks about your use of advanced technologies during your typical driving.

Have you ever disabled or wished you could disable [ADAS]?
(Note: only asked for each of the warning and intervention ADAS present on the vehicle)

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

Please explain for what conditions and why you have disabled or would like to disable [ADAS].

(Note: only asked for each of the warning and intervention ADAS present on the vehicle)

Considering your trips on high speed roads (i.e., speed limit of 50+ mph), how often do you use [ADAS]?

(Note: asked for only one of the driving control ADAS)

* must provide value

- ○ Almost always
- ○ Sometimes
- ○ Occasionally
- ○ Almost never
- ○ Prefer not to answer

Please explain the typical circumstances under which you use and do not use [ADAS]while driving on high speed roads.

(Note: asked for only one of the driving control ADAS)

Please indicate how much you agree or disagree with these statements regarding [ADAS].

(Note: asked for only one of the driving control ADAS)

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Prefer not to answer
I understand which conditions (including environments and roadways) are necessary for **[ADAS]** to work effectively * must provide value	○	○	○	○	○	○
I understand the limitations for **[ADAS]** * must provide value	○	○	○	○	○	○
I can explain **[ADAS]** and its behavior in different situation to others * must provide value	○	○	○	○	○	○

Consider how your driving with [ADAS] compares to driving without any advanced driving technologies. With [ADAS]…

(Note: asked for only one of the driving control ADAS)

	Much less	Less	(No difference)	More	Much more	Prefer not to answer
I drive _____ safely. * must provide value	○	○	○	○	○	○
I am _likely to be involved in a crash. * must provide value						
I pay___attention to driving. * must provide value						
Driving is ____ stressful. * must provide value						
Driving is ____ boring. * must provide value	○	○	○	○	○	○
Driving is ____ enjoyable. * must provide value	○	○	○	○	○	○

Incident Details

The following questions will ask you to provide additional details about your crash or near-crash.

Which best describes the lighting conditions at the time of the incident?

* must provide value

- ○ Daylight
- ○ Dusk
- ○ Dawn
- ○ Dark, roadway lighted
- ○ Dark, roadway not lighted
- ○ Dark, unknown roadway lighting
- ○ I don't recall
- ○ Prefer not to answer

Which best describes the lighting conditions at the time of the incident?

* must provide value

- ☐ Clear
- ☐ Cloudy
- ☐ Fog
- ☐ Rain
- ☐ Snow
- ☐ Other
- ☐ I don't recall
- ☐ Prefer not to answer

Which best describes the condition of the road at the time of the incident?

* must provide value

- ○ Dry
- ○ Wet
- ○ Ice, frost
- ○ Snow
- ○ Slush
- ○ Gravel
- ○ Other
- ○ Prefer not to answer

Which roadway features were present in the location of the incident? Select all that apply.

* must provide value

- ☐ Speed limit above 55 mph
- ☐ Speed limit below 35 mph
- ☐ More than one lane of travel in each direction
- ☐ Lanes divided by median or other barrier
- ☐ Exit or entry ramp
- ☐ Overpass or underpass
- ☐ One-way street
- ☐ On-street parking
- ☐ Faded or missing lane markings
- ☐ Center line rumble strip
- ☐ Shoulder line rumble strip
- ☐ Work zone or road construction
- ☐ Bridge
- ☐ Pedestrian crosswalk
- ☐ Bicycle lane

- ☐ Hill (vertical alignment)
- ☐ Curve (horizontal alignment)
- ☐ Railroad crossing
- ☐ Variable speed limit corridor
- ☐ Dynamic message sign
- ☐ Other
- ☐ None of the above
- ☐ I don't recall
- ☐ Prefer not to answer

Do you know what the posted speed limit was on the road?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

What was the speed limit?

Was there vehicle damage to your vehicle?
(Note: only asked for crashes)

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

Was your vehicle towed from the crash location?
(Note: only asked for crashes)

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

Was anyone involved in the crash injured?
(Note: only asked for crashes)

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

Please indicate your best guess about the level of injury for the person who was most injured in the crash.

* must provide value

- ○ Fatal injury: any injury that results in death within 30 days after the motor vehicle crash
- ○ Major injury: for example, injuries to the skull, chest, or abdomen; significant burns or lacerations; broken limbs
- ○ Minor injury: for example, lump on the head, abrasions, bruises, minor cuts
- ○ Possible injury: momentary loss of consciousness, claim of injury, limping, or complaint of pain or nausea
- ○ I don't know
- ○ Prefer not to answer

Did an officer investigate the crash and complete a crash report?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

Select the type of agency with which the investigating officer was associated.

* must provide value

- ○ State patrol
- ○ County sheriff
- ○ Local police department
- ○ Other
- ○ Unsure
- ○ Prefer not to answer

While the officer was investigating the crash, did the topic of advanced vehicle technology come up?

* must provide value

- ○ The officer brought up the topic
- ○ I mentioned the feature(s) first
- ○ It was not discussed
- ○ Prefer not to answer

Were you given a citation (i.e., a traffic ticket) as a result of the crash?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

Demographics

Please complete this section to provide demographic information.

Age at the time of the incident (enter 999 if you prefer not to answer)	
Sex (as it appears on your license)	
Race	
Highest level of education completed	
Household income	
Miles you drive per year	

Interview Interest

Thank you for completing this survey. We appreciate the time you took to complete it. As mentioned previously, this study also includes an optional interview phase.

The interview will be conducted virtually (over the phone or video call) and will take up to 1.5 hours. Audio and video recordings and a transcription of the interview will be collected. You will be asked to provide additional details about your vehicle and circumstances about the crash or near-crash incident you described in this survey. You may choose to skip any questions during the interview. If you complete the interview, you will receive $50 for your time and effort, and your name and contact information will be deleted from the study's secure data management system within three days of the interview. The video recording will be destroyed after the accuracy of the interview transcript has been verified. This will take no more than 2 weeks. Any potentially identifying information or details will be redacted from the transcript that is used for analysis. When the research study ends, the audio recording and unredacted transcript will be destroyed.

Only a small sample of those who provide contact information will be contacted for the interview. Indicating interest in the interview phase does not obligate you to participate if you are invited. If you are interested in participating in the interview and decide to provide your name and contact information, the research team has up to 90 days to invite you to participate in an interview. If you are not invited to participate, your name and contact information will be deleted from the study's secure data management system.

Are you interested in participating in an interview?

* must provide value

- ○ Yes
- ○ No

Are you able to speak and understand spoken English without difficulty?

* must provide value
- ○ Yes
- ○ No
- ○ Prefer not to answer

Would discussing the crash or near-crash be traumatic for you?

* must provide value
- ○ Yes
- ○ No
- ○ Prefer not to answer

Select the response that best reflects the level of recollection you have for the circumstances prior to the incident.

* must provide value
- ○ I remember very little
- ○ I remember a few details
- ○ I remember some details
- ○ I remember most details
- ○ I remember almost everything
- ○ Prefer not to answer

Select the response that best reflects the level of recollection you have for the circumstances and details of the incident.

* must provide value
- ○ I remember very little
- ○ I remember a few details
- ○ I remember some details
- ○ I remember most details
- ○ I remember almost everything
- ○ Prefer not to answer

Please note that by providing your name and contact information, you are linking your identity to your survey responses. Providing your contact information does not obligate you to participate in the interview. Only a small sample of those who provide contact information will be contacted for the interview phase.

Do you wish to provide your name and contact information?

* must provide value
- ○ Yes
- ○ No

Legal First and Last Name	
Primary Phone Number	
Primary Email	

Would you prefer we use your legal first name or a different name? Different name

What name do you prefer?

We typically use email as our primary method of communication regarding study details, scheduling appointments, and appointment reminders. This may not be the best method for everyone. Please select your preference of communication (email or phone call).

* must provide value

- ○ Email
- ○ Phone

APPENDIX C. MOTORIST INTERVIEW INFORMED CONSENT DOCUMENT

INFORMED CONSENT DOCUMENT

Project Title: An Investigation of the Factors Surrounding Crashes of ADAS-Equipped Vehicles: Motorists

Principal Investigator: Michelle Reyes, 319-335-9563

Research Team Contact: Cheryl Roe, 319-335-6803

This consent form describes the research study to help you decide if you want to participate. This form provides important information about what you will be asked to do during the study, about the risks and benefits of the study, and about your rights as a research subject.

- If you have any questions about or do not understand something in this form, you should ask the research team for more information.
- You should discuss your participation with anyone you choose such as family or friends.
- Do not agree to participate in this study unless the research team has answered your questions and you decide that you want to be part of this study.

WHAT IS THE PURPOSE OF THIS STUDY?

This is a research study. We are inviting you to participate in this research study because you expressed interest in participating in an interview about a crash or near-crash incident that took place while you were operating a passenger vehicle known or believed to be equipped with an Advanced Driver Assistance System (ADAS).

The purpose of this research study is to gather information from motorists regarding their experiences in real-world crashes or near-crashes while operating a vehicle equipped with at least one ADAS feature.

HOW MANY PEOPLE WILL PARTICIPATE?

Approximately 30 people will take part in the motorist interview phase of this study at the University of Iowa.

HOW LONG WILL I BE IN THIS STUDY?

If you agree to take part in this study, your involvement will last up to 1.5 hours. You will be asked to meet virtually one time to participate in an interview. You can choose the location from which you join the virtual meeting.

WHAT WILL HAPPEN DURING THIS STUDY?

An internet hyperlink to a video meeting will be shared with you prior to the interview. This meeting will take place on Microsoft Teams and will require that you have high-speed internet access on a personal device (phone, tablet, laptop, or desktop computer) with video and audio capabilities (i.e., a webcam, microphone, and headphones/speakers). An additional internet hyperlink to an electronic

version of the informed consent document will be included. This link cannot be opened until a researcher provides you with your unique pass code. You will receive an email reminder of the meeting with both hyperlinks about two hours prior to the meeting.

During the first part of the meeting, a researcher will verbally explain the purpose and procedures involved in the study and answer any questions you may have about participation. You will be asked to sign the consent document electronically. Then, you will provide a mailing address for the payment form.

Upon completion of the paperwork, a second researcher will join the call. Next, a short test will be conducted to verify that the equipment is recording audio and video and that the transcription is working. Following verification, the interview will begin. One researcher will conduct the interview. The other will ensure that the recordings are working properly and take notes during the interview. During the interview, you will be asked about the vehicle (year, make, model, ADAS feature(s), etc.) you were operating at the time of the crash or near-crash, understanding and use of the ADAS feature(s) on the vehicle, as well as characteristics of the crash or near-crash (e.g., date, time, weather, type of crash). You may skip any questions you do not wish to answer. At the completion of the interview, recording will be stopped, and a researcher will finalize your payment.

Data Storage for Future Use

As part of this study, we are obtaining audio and video data, an interview transcript, and survey data from you. We would like to study your responses in the future, after this study is over. Other qualified researchers who obtain proper permission may gain access to your data for use in approved research studies that may or may not be related to the purpose of this study. This process could occur without additional informed consent from you.

These future studies may provide additional information about how understanding of ADAS features varies across drivers, but it is unlikely that what we learn from these studies will have a direct benefit to you. It is possible that the interview transcripts and survey data might be used to develop products, tests, or discoveries that could be patented and licensed. In some instances, these may have potential commercial value and may be developed by the Investigators, University of Iowa, commercial companies, organizations funding this research, or others that may not be working directly with this research team. There are no plans to provide financial compensation to you should this occur.

Your interview transcript and survey data will be stored *without* your name or any other kind of link that would enable us to identify which sample(s) are yours. Therefore, if you give permission to store your interview transcript and survey data, it will be available for use in future research studies indefinitely and cannot be removed. Your video data will not be available for future studies as it will only be retained through the verification of the interview transcript, which will be completed no more than 2 weeks after the interview. The audio data will not be available for future studies as it will only be retained through study closure.

Audio/Video Recording or Photographs

One aspect of this study involves making audio and video recordings of you. By participating in this

study, you consent to such recordings. These are necessary for the researchers to examine interview responses. Access to this data will be under the supervision of study investigators or as required by law.

The interview will be recorded using digital video/audio through a web platform called Microsoft Teams. The recording will include a view of your face and the interviewer's face. Teams will also perform transcription of the interview. In addition to the recording in Teams, a second audio recording will be made using voice recording computer software. This recording is a backup in case there are issues with the Teams recording.

All video and audio collected prior to you stopping or completing your participation will be analyzed and retained as specified.

WHAT ARE THE RISKS OF THIS STUDY?

You may experience one or more of the risks indicated below from being in this study. In addition to these, there may be other unknown risks, or risks that we did not anticipate, associated with being in this study.

- You may experience some anxiety and/or discomfort because you will be asked to provide information about a motor vehicle crash or near-crash.
- Loss of confidentiality is always considered a risk.

To minimize risk, you will be allowed to choose the location for your interview. You will be given ample time to answer the questions and can choose to skip questions. Within three days of completing the interview, your name and contact information will be removed from in the study's secure data management system. Within two weeks of the interview, the video recording will be destroyed. Any potentially identifying information or details will be redacted from the transcript that is used for analysis. When the research study ends, the audio recording and unredacted transcript will be destroyed.

WHAT ARE THE BENEFITS OF THIS STUDY?

You will not benefit from being in this study.

However, we hope that, in the future, other people might benefit from this study because the information gained may help to identify knowledge gaps for motorists when it comes to the understanding of ADAS features on motor vehicles and how to better inform motorists about them.

WILL IT COST ME ANYTHING TO BE IN THIS STUDY?

You will not have any costs for being in this research study.

WILL I BE PAID FOR PARTICIPATING?

You will be paid $50 for completing the interview. If you wish to stop the interview prior to completion, you will be compensated $15. You will need to provide your address in order to receive payment by check or direct deposit. If you wish to be paid via direct deposit, please have your bank information (routing and account number) available so you are able to provide this on your payment form.

WHO IS FUNDING THIS STUDY?

Iowa Department of Transportation (IDOT) and the Colorado Department of Transportation (CDOT) are funding this research study. This means that the University of Iowa is receiving payments from IDOT and CDOT to support the activities that are required to conduct the study. No one on the research team will receive a direct payment or increase in salary from IDOT or CDOT for conducting this study.

WHAT ABOUT CONFIDENTIALITY?

We will keep your participation in this research study confidential to the extent permitted by law. However, it is possible that other people such as those indicated below may become aware of your participation in this study and may inspect and copy records pertaining to this research. Some of these records could contain information that personally identifies you. These people include

- federal government regulatory agencies,
- auditing departments of the University of Iowa,
- the study sponsor or its agents, and
- the University of Iowa Institutional Review Board (a committee that reviews and approves research studies).

Under extreme and extraordinary circumstances and under advisement from the General Counsel, law enforcement may be provided information that includes your identity. Authorities could subpoena our records if accidents or illegal activities are captured.

To help protect your confidentiality, we will assign a study number to you which will be used instead of your name to identify all data collected for the study. The list linking your study number and your name will be stored in a secure location and will be accessible only to the researchers at the University of Iowa. All records and data containing confidential information will be maintained in locked offices or on secure password-protected computer systems that are accessible to the researchers, the study sponsor, and its agents. Study documents are identified by subject number only, except the Informed Consent which will be identified by your last name and first initial and stored in a separate digital folder than other study documents. The digital records of informed consent will be destroyed six years after the study closes.

If we write a report or article about this study or share the study data set with others, we will do so in such a way that you cannot be directly identified by name. The video recording will be destroyed after the accuracy of the interview transcript has been verified. Any potentially identifying information or details will be redacted from the transcript that is used for analysis. When the research study ends, the audio recording and unredacted transcript will be destroyed.

IS BEING IN THIS STUDY VOLUNTARY?

Taking part in this research study is completely voluntary. You may choose not to take part at all. If you decide to be in this study, you may stop participating at any time. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized or lose any benefits for which you otherwise qualify.

What if I Decide to Drop Out of the Study?

If you are unable to complete the interview once it has begun, you will receive $15. If you decide to withdraw participation after your interview has taken place but prior to study completion, all video, audio, and data associated with your interview will be destroyed.

Can Someone Else End my Participation in this Study?

Under certain circumstances, the researchers might decide to end your participation in this research study earlier than planned. This might happen if you behave inappropriately or are non-compliant or if there are technical difficulties.

WHAT IF I HAVE QUESTIONS?

We encourage you to ask questions. If you have any questions about the research study itself, please contact: **Michelle Reyes (319-335-9563) or Cheryl Roe (319-335-6803).** If you experience a research-related injury, please contact **Michelle Reyes (319-335-9563)**.

If you have questions, concerns, or complaints about your rights as a research subject or about research related injury, please contact the Human Subjects Office, 105 Hardin Library for the Health Sciences, 600 Newton Rd, The University of Iowa, Iowa City, IA 52242-1098, (319) 335-6564, or e-mail irb@uiowa.edu. General information about being a research subject can be found by clicking "Info for Public" on the Human Subjects Office web site, http://hso.research.uiowa.edu/. To offer input about your experiences as a research subject or to speak to someone other than the research staff, call the Human Subjects Office at the number above.

This Informed Consent Document is not a contract. It is a written explanation of what will happen during the study if you decide to participate. You are not waiving any legal rights by signing this Informed Consent Document. Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Subject's Name (printed): _____

_____ _____
(Signature of Subject) (Date)

Statement of Person Who Obtained Consent

I have discussed the above points with the subject or, where appropriate, with the subject's legally authorized representative. It is my opinion that the subject understands the risks, benefits, and

procedures involved with participation in this research study.

_____ _____

(Signature of Person who Obtained Consent) (Date)

APPENDIX D. MOTORIST INTERVIEW GUIDE

Interview preparation example

2016 GMC Acadia Denali	
Crash: Front to Side Date/Environment: March 2023, IA, Daylight, Clear, Dry, More than 1 lane in each direction Speed limit: 35 mph Description: went to merge right on four way car beside me speed up we hit	
Adaptive Cruise Control	
Participant response	The vehicle had this system and I am confident it was active at the time of the incident.
OEM system name	N/A: Not equipped
Description/notes from manual	
Lane Centering Assistance	
Participant response	The vehicle had this system, and I am confident it was active at the time of the incident.
OEM system name	N/A: Not equipped
Description/notes from manual	
Active Driving Assistance	
Participant response	The vehicle had this system, and I am confident it was active at the time of the incident.
OEM system name	N/A: Not equipped
Description/notes from manual	
Automatic Emergency Braking	
Participant response	The vehicle had this system, and I am confident it did not intervene during the incident.
OEM system name	N/A: Not equipped
Description/notes from manual	
Automatic Emergency Steering	
Participant response	The vehicle had this system, and I am confident it did not intervene during the incident.
OEM system name	N/A: Not equipped
Description/notes from manual	
Lane Keeping Assistance	
Participant response	The vehicle had this system, and I am confident it did not intervene during the incident.
OEM system name	N/A: Not equipped
Description/notes from manual	
Blind Spot Warning	

Participant response	The vehicle had this system enabled at the time of the incident and I am confident it did not issue a warning.
OEM system name	Side Blind Zone Alert (SBZA)
Description/notes from manual	If equipped, the Side Blind Zone Alert system is a lane-changing aid that assists drivers with avoiding crashes that occur with moving vehicles in the side blind zone (or spot) areas. The SBZA warning display will light up in the corresponding outside side mirror and will flash if the turn signal is on.
Forward Collision Warning	
Participant response	The vehicle had this system enabled at the time of the incident and I am confident it did not issue a warning.
OEM system name	Forward Collision Alert System (FCA)
Description/notes from manual	If equipped, the FCA system may help to avoid or reduce the harm caused by front-end crashes. When approaching a vehicle ahead too quickly, FCA provides a red flashing visual alert on the windshield and rapidly beeps. FCA also lights an amber visual alert if following another vehicle much too closely. FCA detects vehicles within a distance of approximately 60m (197 ft) and operates at speeds above 40 km/h (25 mph). Alert timings: Far, Medium, near or off
Lane Departure Warning	
Participant response	The vehicle had this system enabled at the time of the incident, but I am not sure if it issued a warning.
OEM system name	Lane Departure Warning (LDW)
Description/notes from manual	If equipped, LDW may help avoid crashes due to unintentional lane departures. It may provide an alert if the vehicle is crossing a lane without using a turn signal in that direction. LDW uses a camera sensor to detect the lane markings at speeds of (35 mph) or greater. Camera in windshield. Visual Green to warn, Amber and flashing when warning and three audio beeps on side of warning.
Other notes	
ADA had no impact on the outcome Did not do what was expected. “It didn’t do anything.” Expected behavior: “a beep or a correction” Almost always uses ADA on high-speed roads. Typical circumstances: “I really don’t no use”	

Interview

Thank you once again for making the time to talk with us today. We want to learn about your experiences with advanced vehicle technologies, particularly when they have been involved in a crash or near-crash. You indicated an incident of this type in your initial survey. The interview today will focus on the vehicle you were operating at the time of the incident and the incident itself. If you would like to skip a question, you can just say “pass” or “I’d prefer to not answer that question.” Since we are recording, to maintain your confidentiality we will refrain from using your name. During your responses, you may wish to avoid using other individual’s names. If you happen to say someone’s name, please know that we will redact it from the interview transcript. If at any time you need a break, just let me know. You are the expert here, and we cannot do this project without the help of

people like you, so thank you for talking to us today. Do you have any questions before we start recording?

After addressing any questions, the second researcher will begin the recording.

We are going to begin the interview today with some questions about your vehicle.

Vehicle

- ☐ I have your vehicle listed as a Year, Make, Model, Trim. Is that accurate?
- ☐ When did you get this vehicle?
- ☐ Was the vehicle new when you got it?
- ☐ (If vehicle is not new) Would you mind telling me where you got the [Model]? Specifically, did you get it from a [Make dealership], a different dealership, a used car auto store, private party sale, purchase from friend/family member, or online seller?
- ☐ Do you still have this vehicle?

Driving

- ☐ Is the [Model] your primary vehicle?
- ☐ How often do you drive the [Model]?
- ☐ Can you estimate how many miles you drive in the [Model] in a typical week or month?
- ☐ How would you rate your level of comfort with driving the [Model] on a scale from 0 to 5, with 0 being very uncomfortable and 5 being very comfortable?
    - Can you describe what aspects of driving you thought about when giving your rating?

When you completed the survey for our study, you described an incident involving your [Model]. We are going to talk about that next.

- ☐ Incident Can you please go back in your mind to the day of the incident and tell me what happened?
- ☐ What happened next? And then what happened next?
- ☐ What happened before that?

Transition – Thank you for telling us about your experience. If it is ok with you, we would like to talk with you about some of the details about the incident.

- ## Prior to incident What was the **purpose** of the trip you were taking when the incident occurred?
    - Where were you going?
    - Where were you coming from?
- How would you describe your **familiarity** with the roadway?
- What **time of the day** was the incident?
    - How long had you been driving?
- What was the **weather** like?
    - Were you using your headlights, turn signal, hazard lights, or windshield wipers?
- Now I would like to learn more about the **roadway** you were on**.** What do you recall about the road features, road conditions?
    - How many **lanes** of traffic?
    - Was there parking along the street?
    - Was there a shoulder along the roadway?
    - Which lane were you positioned in?
    - Do you remember what the **lane markings** looked like?
        - Color
        - New or worn?
        - Right and left lane?
    - What can you recall about the **pavement**?
        - Dry vs wet
        - Concrete, asphalt, pavers/cobblestones
        - Newly paved vs old
    - Do you recall the **speed limit** on the road?
        - Your speed?
- Now, I would like you to think about the **TRAFFIC** around you at the time of the incident. What can you tell me about that? [ahead/next to you/behind]
- Now, I would like you to think about the **atmosphere inside the vehicle**. What can you tell me about that?
    - Was anyone in the vehicle with you? What were they doing?
    - Was anything going on in the vehicle? Were you talking? Listening to anything on the radio or your phone?
    - Do you recall what you were **thinking** about? If yes, would you mind sharing with me what you were thinking about?
    - How were **you feeling** just before the incident happened? (Relaxed vs stressed, energetic vs tired)
- Is there anything else you would like to add about what was going on with your car, or with the environment inside or outside the vehicle?

SUMMARIZE WHAT THEY SAID BEFORE TRANSITIONING TO "DURING THE INCIDENT"

During the incident

- What was your first indication that something was not right?

- Do you remember what the vehicle [ahead/next to you/behind] of you was doing, for example, did it brake, swerve or doing something else?
    - If applicable, what about the vehicles behind you? In the lanes next to you?
- What action did you take?
- What did you do next?
- How close did you get to the other vehicle?
- Do you think you were in danger of losing control of your vehicle?

Post-incident

- Looking back, is there anything you would have done differently?

For crashes only

- Was a crash investigation done? How many officers were on the scene? How many did you speak with?
- Did your vehicle have to be towed?
- Was anyone injured?

Before we continue, I am going to mute my microphone for a moment to check-in with my colleague. If you would like to get up stretch, grab a drink of water that would be fine.

Vehicle Technologies during the incident

NOTE: Enter ADAS active, ADAS that provided warning

You may recall that the survey you completed asked you about several different types of advance vehicle technologies. These systems are often referred to as Advanced Driver Assistance Systems or ADAS. They monitor the driving environment and may warn you of potential collisions, provide intervention during potential collisions, or may provide driving control assistance. The next part of the interview focuses on these systems. As we talk about them, I may refer to them as technologies, features, or ADAS.

- When you completed the survey, you mentioned several different ADAS being active during the incident. What can you tell us about those?.

ADA: Include ADAS survey response

In the survey, you mentioned that the Active Driving Assist was active at the time of the incident. Can you tell me more about that?

- Tell me what you remember about the Active Driving Assist prior to the incident.
    - How did you know that it was active?
- Please describe the behavior of the Active Driving Assist during the incident.
- Did you have any thoughts about the Active Driving Assist after the incident? If so, do you mind sharing?
- Did the Active Driving Assist behave in the way that you expected?

- Do you think having the Active Driving Assist affected the outcome of the incident in any way? If so, how?

ACC: Include ADAS survey response

In the survey, you mentioned that the Adaptive Cruise Control was active at the time of the incident. Can you tell me more about that?

- Tell me what you remember about the Adaptive Cruise Control prior to the incident.
    - How did you know that it was active?
- Please describe the behavior of the Adaptive Cruise Control during the incident.
- Did you have any thoughts about the Adaptive Cruise Control after the incident? If so, do you mind sharing?
- Did the Adaptive Cruise Control behave in the way that you expected?
- Do you think having the Adaptive Cruise Control affected the outcome of the incident in any way? If so, how?

LCA: Include ADAS survey response

In the survey, you mentioned that the Lane Centering Assist was active at the time of the incident. Can you tell me more about that?

- Tell me what you remember about the Lane Centering Assist prior to the incident.
    - How did you know that it was active?
- Please describe the behavior of the Lane Centering Assist during the incident.
- Did you have any thoughts about the Lane Centering Assist after the incident? If so, do you mind sharing?
- Did the Lane Centering Assist behave in the way that you expected?
- Do you think having the Lane Centering Assist affected the outcome of the incident in any way? If so, how?

AEB: Include ADAS survey response

In the survey, you also indicated that the Automatic Emergency Braking intervened during the incident. Can you tell me more about that?

- Please describe the behavior of the Automatic Emergency Braking during the incident.
- Did you have any thoughts about the Automatic Emergency Braking after the incident? If so, do you mind sharing?
- Did the Automatic Emergency Braking behave in the way that you expected?
- Do you think having the Automatic Emergency Braking affected the outcome of the incident in any way? If so, how?

AES: Include ADAS survey response

In the survey, you also indicated that the Automatic Emergency Steering intervened during the incident. Can you tell me more about that?

- Please describe the behavior of the Automatic Emergency Steering during the incident.
- Did you have any thoughts about the Automatic Emergency Steering after the incident? If so, do you mind sharing?
- Did the Automatic Emergency Steering behave in the way that you expected?
- Do you think having the Automatic Emergency Steering affected the outcome of the incident in any way? If so, how?

LKA: Include ADAS survey response

In the survey, you also indicated that the Lane Keeping Assist intervened during the incident. Can you tell me more about that?

- Please describe the behavior of the Lane Keeping Assist during the incident.
- Did you have any thoughts about the Lane Keeping Assist after the incident? If so, do you mind sharing?
- Did the Lane Keeping Assist behave in the way that you expected?
- Do you think having the Lane Keeping Assist affected the outcome of the incident in any way? If so, how?

BSW: Include ADAS survey response

In the survey, you also indicated that the Blind Spot Warning issued a warning during the incident. Can you tell me more about that?

- Please describe the behavior of the Blind Spot Warning during the incident.
- Did you have any thoughts about the Blind Spot Warning after the incident? If so, do you mind sharing?
- Did the Blind Spot Warning behave in the way that you expected?
- Do you think having the Blind Spot Warning affected the outcome of the incident in any way? If so, how?

FCW: Include ADAS survey response

In the survey, you mentioned that the Forward Collision Warning issued a warning during the incident. Can you tell me more about that?

- Please describe the behavior of the Forward Collision Warning during the incident.
    - How close was the other vehicle?
- Did you have any thoughts about the Forward Collision Warning after the incident? If so, do you mind sharing?
- Did the Forward Collision Warning behave in the way that you expected?
- Do you think having the Forward Collision Warning affected the outcome of the incident in any way? If so, how?

LDW: Include ADAS survey response

In the survey, you also indicated that the Lane Departure Warning issued a warning during the incident. Can you tell me more about that?

- Please describe the behavior of the Lane Departure Warning during the incident.
- Did you have any thoughts about the Lane Departure Warning after the incident? If so, do you mind sharing?
- Did the Lane Departure Warning behave in the way that you expected?
- Do you think having the Lane Departure Warning affected the outcome of the incident in any way? If so, how?

For crashes only

- Think about your interactions with the officer(s) at the scene of the crash. Did they ask you anything about [ADAS] specifically or advanced vehicle technologies in general?
- Did you mention [ADAS] to the officer?

ADAS on your vehicle – Prior Experience

Enter appropriate ADAS

Now, I would like to circle back to your experiences with the ADAS features on your vehicle PRIOR to the incident.

- Besides the [ADAS discussed in the context of the incident], are there any other ADAS features on your vehicle?

[Wording for asking whether they have a certain system, if needed] We could tell from the owners manual for the [Model] that some trim levels have [ADAS] but it does not say which ones. Do you know if your [Model] has any [describe system, e.g., assistance for lane keeping]?

- How did the ADAS features on the vehicle factor into your decision to purchase the vehicle?
    - Which ADAS were most appealing to you and why?
    - What were your reasons for purchasing the system?

- Was this vehicle the first experience you had with [ADAS]?
    - Are there any major differences between how the systems work on your [Model] and your previous vehicle? Can you please tell me about those?
    - Did any of those differences cause confusion?
    - If not, please describe your previous experiences.

- Thinking about your driving prior to this incident, have there been any times when any of the ADAS features in your [Model] behaved in a way that surprised you?
    - Can you tell me about those situations?
    - What about the behavior was surprising? What were you expecting it to do?

- If this situation happened again today, would it still surprise you?
- If no, ask again for their previous vehicle, if applicable.

ADAS Education

Enter appropriate ADAS

The next set of questions focus on how you learned about the ADAS features.

- Prior to purchasing the [Model], what did you know about the ADAS features?
  - What systems?
  - Where did the information come from?

- What information did the [dealership or seller] provide?
  - When did they offer that information?
  - How did they share the information? (Demo, brochure, website)

- What can you tell me about the owner's manual for your [Model]?
  - What information were you looking for?
  - Were you able to find it?
  - Can you share with me what was most helpful?
  - Was there anything missing?
  - Something you wanted to know but were unable to find?
  - If didn't read or open: There are many reasons people do not use their owner's manual. Are there specific reasons why you haven't looked at your manual?

- Besides what we have already discussed, were there any other ways you learned about the [ADAS]? (Web search, friend, family)

- Which learning method was most effective for you and why?

- Is there anything that you know now, about the [ADAS] in your Model, that would have been useful to know, before you purchased or began driving the vehicle?

- If PREVIOUS experience: You mentioned having experience with other vehicles with [ADAS]. How does the [ADAS] on the [Model] compare to your previous experience(s)?
  - How was the transition to the [Model]?
  - Did your experience(s) with the [ADAS] on your previous vehicle(s) affect your understanding of the [ADAS] on your [Model]?

Before we continue, I am going to mute my microphone for a moment to check-in with my colleague. If you would like to get up stretch, grab a drink of water that would be fine. When we resume, we will have one more block of questions.

Researchers to discuss which ADAS to focus on for Mental Model.

ADAS Mental Model

Enter appropriate ADAS

Are you ready to start the last part of the interview?

- To begin with, how would you rate your level of understanding for the [ADAS], on a scale from 0 to 5, with 0 being very low and 5 being very high? You are welcome to give ratings for each system if you'd prefer to do that.

- How long did it take for you to reach that level of understanding?
    - Can you tell me more about that?

- How would you describe the [ADAS] in your vehicle to one of your friends or family members?
    - What does it do?
    - How do you use it?
    - When can you use it? What conditions (including environments and roadways) are necessary for to work effectively?

- How can you tell when the [ADAS] is **active/intervening/enabled**?

- Are the different options on how it alerts you?

- Have you ever disabled or wish you could disable the [ADAS]?
    - Please explain the circumstances and why you have disabled or why you would like to disable the ADAS].

- Do you think having the [ADAS] has changed the way you drive? If so, how.

- If you were talking to a design team, what feedback would you share regarding the [ADAS] system in your vehicle? Are there any changes that you would suggest?

Thank you very much for taking the time to speak with us today. We really appreciate you helping us to understand your experiences with the advanced technology/ies on your vehicle.

Do you have anything else you would like to add about your vehicle or your incident?

Do you have any questions for us?

OK, Great. We will stop recording now.

Stop Recording

Researcher will provide information about the payment and how to reach out with questions in the future.

APPENDIX E.1. IOWA OFFICER EMAIL

Subject: research on crashes involving advanced vehicle technologies

Hello, Sir or Madam:

We are from the University of Iowa Driving Safety Research Institute. We are inviting law enforcement officers to participate in a research study. Would you please consider forwarding this message to the officers who serve in your agency so they can consider participating?

We are studying the impact of advanced vehicle technologies on motor vehicle crashes. Most passenger vehicles manufactured in the last 5 years are equipped with advanced technologies that can provide warnings, intervene by providing braking or steering, and/or automate part of the driving task.

One aspect of our research is learning more about how officers investigate crashes involving vehicles equipped with these technologies. Our findings might make it easier for officers to investigate the involvement of advanced technologies in future crashes.

We are inviting law enforcement officers to complete an online survey (about 10 minutes) or to participate in a virtual interview (up to 45 minutes). Use this link to learn more about participating: redcap.link/crashtech_le.

You can find additional information about the study below. Feel free to contact me with any questions.

Thank you for your consideration,

Cherie Roe
AV Transportation and Outreach Specialist
cheryl-roe@uiowa.edu

Additional study details:

Who is conducting the research study? The research study is being conducted by the Driving Safety Research Institute (formerly known as The National Advanced Driving Simulator) at the University of Iowa. Michelle Reyes is the Principal Investigator and Cheryl Roe is the Co-Investigator and Project Manager.

Who is funding the research study? This research project is being funded by the Iowa DOT and the Colorado DOT.

Who can participate? Anyone currently employed as a law enforcement officer in either the State of Iowa or the State of Colorado who has completed at least one motor vehicle crash report in the last three months is eligible to participate. Participating in the research study is completely voluntary.

How can officers participate? Participants have the choice of providing information through either an interview (virtual meeting up to 45 minutes) or an anonymous online survey (approximately 10 minutes). Both methods will ask questions about your understanding of advanced vehicle technologies, your approach to ascertaining the role the vehicle technologies may have played in contributing to or mitigating a crash, how you include that information on the crash report, and training related to vehicle technologies.

Will officers be compensated for participating? Participants will not be paid for participating in this research study.

APPENDIX E.2. COLORADO OFFICER EMAIL

Subject: research on crashes involving advanced vehicle technologies

Hello, Sir or Madam:

We are from the University of Iowa Driving Safety Research Institute. We are inviting law enforcement officers to participate in a research study co-sponsored by the Colorado Department of Transportation. Would you please consider forwarding this message to the officers who serve in your agency so they can consider participating?

We are studying the impact of advanced vehicle technologies on motor vehicle crashes. Most passenger vehicles manufactured in the last 5 years are equipped with advanced technologies that can provide warnings, intervene by providing braking or steering, and/or automate part of the driving task.

One aspect of our research is learning more about how officers investigate crashes involving vehicles equipped with these technologies. Our findings might make it easier for officers to investigate the involvement of advanced technologies in future crashes.

We are inviting law enforcement officers to complete an online survey (about 10 minutes) or to participate in a virtual interview (up to 45 minutes). Use this link to learn more about participating: redcap.link/crashtech_le.

You can find additional information about the study below. Feel free to contact me with any questions.

Thank you for your consideration,

Cherie Roe
AV Transportation and Outreach Specialist
cheryl-roe@uiowa.edu

Additional study details:

Who is conducting the research study? The research study is being conducted by the Driving Safety Research Institute (formerly known as The National Advanced Driving Simulator) at the University of Iowa. Michelle Reyes is the Principal Investigator and Cheryl Roe is the Co-Investigator and Project Manager.

Who is funding the research study? This research project is being funded by the Iowa DOT and the Colorado DOT.

Who can participate? Anyone currently employed as a law enforcement officer in either the State of Iowa or the State of Colorado who has completed at least one motor vehicle crash report in the last three months is eligible to participate. Participating in the research study is completely voluntary.

How can officers participate? Participants have the choice of providing information through either an interview (virtual meeting up to 45 minutes) or an anonymous online survey (approximately 10 minutes). Both methods will ask questions about your understanding of advanced vehicle technologies, your approach to ascertaining the role the vehicle technologies may have played in contributing to or mitigating a crash, how you include that information on the crash report, and training related to vehicle technologies.

Will officers be compensated for participating? Participants will not be paid for participating in this research study.

APPENDIX E.3. OFFICER SOCIAL MEDIA POST

DSRI is recruiting law enforcement officers from Iowa and Colorado to help us learn about crash reporting. Use this link to learn more https://redcap.link/crashtech_le. Please share with officers you know.

APPENDIX E.4. OFFICER RECRUITMENT POSTCARD

APPENDIX F. OFFICER SURVEY

Thank you for your interest in our study!

This research study is being conducted by investigators from the University of Iowa Driving Safety Research Institute. This purpose of this study is to gather information from officers about their approach to investigating motor vehicle crashes, particularly when the vehicle(s) involved may be equipped with advanced vehicle technologies. Study participants can provide information through either an interview or an online survey.

Are you employed as a law enforcement officer?

* must provide value

◯ Yes ◯ No

In which state are you employed?

* must provide value

◯ Iowa

◯ Colorado

◯ Other _____

In the last 3 months, have you completed at least one motor vehicle crash report form?

* must provide value

◯ Yes ◯ No

Elements of Consent

Project Title: Investigation of Crashes Involving ADAS-Equipped Vehicles

Principal Investigator: Michelle Reyes, 319-335-9563

We invite you to participate in a research study being conducted by investigators from the University of Iowa Driving Safety Research Institute. The purpose of this study is to gather information from officers about their approach to investigating motor vehicle crashes, particularly when the vehicle(s) involved may be equipped with advanced vehicle technologies.

We are inviting you to be in this study if you are employed as a law enforcement officer in either the State of Iowa or the State of Colorado and you have completed at least one motor vehicle crash report in the last three months. Study participants have the choice of providing information through either an interview or an online survey. Both methods will ask questions about your understanding of advanced vehicle technologies, your approach to ascertaining the role the ADAS features may have played in contributing to or mitigating a crash, how you include ADAS-related information on the crash report, and training you may have received.

The interviews will take place on an online meeting platform on a weekday between 7:30 am and 9:00 pm and will last up to 45 minutes. Two members of our research team will be present during the virtual interview. If you are interested in participating in the interview, we will immediately ask you a few

questions about your experience and availability and collect your name and contact information. Not all those who provide contact information will be invited for an interview. If you provide your name and contact information, the research team has up to 45 days to invite you to participate in an interview. If you are not invited to participate in the interview, or you decline the invitation, your name and contact information will be deleted from the study's secure data management system. Indicating interest in the interview does not obligate you to participate if you are invited.

If you are interested in participating in the anonymous survey, you will be immediately directed to the online survey. You are allowed to indicate "Prefer not to answer" for any questions that you want to skip. Completing the survey will take approximately 10 minutes.

You may experience some anxiety and/or discomfort while providing information for this study. Loss of confidentiality is always considered a risk.

We will keep your participation in this research study confidential to the extent permitted by law. However, federal regulatory agencies and the University of Iowa Institutional Review Board (a committee that reviews and approves research studies) may inspect and copy records pertaining to this research.

To help protect your confidentiality, we will assign you a unique code that will be used to identify all data collected for the study. The list linking your unique code and your name (if you choose to provide it) will be stored in a secure location and will be accessible only to the researchers at the University of Iowa. All records and data containing confidential information will be maintained in locked oices or on secure password-protected computer systems that are accessible to the researchers. If we write a report about this study, we will do so in such a way that you cannot be identified. The study sponsor may have access to your de-identified data (that is, data without your name).

Your de-identified survey or interview transcript data will also be retained for use in future research studies, after this study is over. Other qualified researchers who obtain proper permission may gain access to your de-identified data for use in approved research studies that may or may not be related to in the purpose of this study. These future studies may provide additional information that will be helpful in understanding crashes involving advanced vehicle technologies, but it is unlikely that what we learn from these studies will have a direct benefit to you. If you agree to provide data for this study, you are giving permission for your de-identified data to be stored for use in future research studies indefinitely and this permission cannot be removed.

You will not benefit personally from being in this study. However, we hope that others, including law enforcement officers, state agencies, and motorists, may benefit in the future from what we learn as a result of this study.

You will not have any costs for being in this research study.

You will not be paid for participating in this research study.

Taking part in this research study is completely voluntary. If you decide not to be in this study, or if you stop participating at any time, you won't be penalized or lose any benefits for which you otherwise qualify.

If you have any questions or problems with completing the survey, please contact Cheryl Roe at the University of Iowa at 319-335-6803 or by email at cheryl-roe@uiowa.edu. If you have questions about the rights of research subjects, please contact the Human Subjects Office, 105 Hardin Library for the Health Services, 600 Newton Rd, The University of Iowa, Iowa City, IA 52242-1098, (319)

335-6564 or email irb@uiowa.edu. To offer input about your experience as a research subject or to speak to someone other than the research staff, call the Human Subjects Office at the number above.

Thank you very much for your consideration. Are you interested in completing the survey? By selecting "Yes," you are consenting to provide us with information. Researchers will have access to this data.

* must provide value

○ Yes ○ No

Are you interested in learning more about the interview?

* must provide value

○ Yes ○ No

The survey for this research study will ask you to provide information about your approach to investigating crashes, your understanding of advanced vehicle technologies, your approach to ascertaining the role vehicle technologies may have played in contributing to or mitigating a crash, how you include technology-related information on the crash report, and training related to these topics. You are allowed to indicate "Prefer not to answer" for any questions that you want to skip. Completing the survey will take approximately 10 minutes.

Are you interested in participating in the survey?

* must provide value

○ Yes ○ No

When completing this anonymous survey, you are encouraged to use examples from your own crash investigations to illustrate your approach to investigating crashes. However, please do not share the identities of individuals or locations and do not provide dates of crashes. You can mention specific vehicle makes and/or models if they are relevant to your example(s).

* must provide value

☐ I acknowledge the request and agree to not provide information that includes crash dates or identifies individuals or specific locations

Select the type of agency with which you are employed.

* must provide value

○ State patrol
○ County sheriff
○ Local police department
○ Other
○ Prefer not to answer

How many years of experience do you have doing crash reports?

* must provide value

- ○ Less than 1 year
- ○ At least 1 year but less than 3 years
- ○ At least 3 years but less than 5 years
- ○ At least 5 years but less than 10 years
- ○ More than 10 years
- ○ Prefer not to answer

In the last three months, approximately how many crash reports did you complete?

* must provide value

- ○ Less than 5
- ○ At least 5 but less than 10
- ○ At least 10 but less than 20
- ○ More than 20
- ○ Prefer not to answer

Please describe the steps you typically use to conduct a crash investigation. Do not include information related to your arrival at the scene and rendering aid to injured people.

We are interested in learning about the experiences of law enforcement officers when investigating crashes involving passenger vehicles equipped with advanced vehicle technologies. These systems are often referred to as Advanced Driver Assistance Systems (ADAS).

Please provide your definition of ADAS.

Advanced Driver Assistance Systems have several different definitions and classifications. Here is the definition that we have selected for the purpose of this research study.

Advanced Driver Assistance Systems (ADAS) monitor the driving environment and may warn a driver of potential collision, provide intervention during potential collision, or provide driving control assistance.

Systems **that provide a warning** when a potential collision is detected, for example:

- blind spot warning
- lane departure warning
- forward collision warning

Systems that **provide assistance** when a potential collision or lane departure is detected,

for example:

- automated emergency braking
- automated emergency steering
- lane keeping assistance

Systems that **provide driving control assistance** when certain conditions are met,

for example:

- adaptive cruise control
- lane centering assistance
- active driving assistance

The next set of questions will ask you about ADAS and how often you consider ADAS when doing a crash investigation.

Do you consider Advanced Driver Assistance Systems (ADAS) as a routine part of your crash investigation protocol?

* must provide value

- ○ Never
- ○ Rarely
- ○ Infrequently
- ○ Sometimes
- ○ Usually
- ○ Always
- ○ Prefer not to answer

What circumstances lead you to consider ADAS during crash investigations? Check all that apply.

(Note: Question appears for "Rarely", "Infrequently", "Sometimes" and "Usually")

* must provide value

- ☐ Driver told me the vehicle had an ADAS
- ☐ I noticed cameras or sensors on the exterior of the vehicle
- ☐ Vehicle model year was relatively new
- ☐ Agency expects me to include it in my investigation
- ☐ Other
- ☐ Prefer not to answer

Have you ever done any of the following while conducting any crash investigations? Check all that apply.

(Note: Question appears for all for responses except "Never")

* must provide value

- [ ] Performed a VIN look-up to determine whether the vehicle was equipped with a certain ADAS technology
- [ ] Obtained the owner's manual for a vehicle to determine whether the vehicle was equipped with a certain ADAS technology
- [ ] Obtained the owner's manual to learn how a specific ADAS technology is intended to function
- [ ] Obtained vehicle event data recorder (EDR) data to determine ADAS status at the time of crash Vehicle model year was relatively new
- [ ] Sought information from a different source to help me learn about ADAS technology on a vehicle involved in a crash
- [ ] None of these
- [ ] Prefer not to answer

Please describe the different source(s) from which you sought information about ADAS technology a vehicle involved in a crash.

Would you like to provide any additional information or details about how you learn about ADAS while conducting crash investigations?

Please describe the reasons why you do not consider ADAS when conducting crash investigations.

(Note: Questions appears for "Never")

Crash Reports

Please describe how you indicate on the Colorado Traffic Crash Report the presence of ADAS on the vehicle and impact of ADAS on the crash.

Imagine that the Colorado crash report form is being revised to modify how information related to ADAS technologies is collected. Please describe any revisions that you would suggest.

Please describe how you indicate on the Iowa Traffic Crash Report the presence of ADAS on the vehicle and impact of ADAS on the crash.

Imagine that the Iowa crash report form is being revised to include new fields for information related to ADAS technologies. Please describe your preference for the revisions, including the number and type of fields you would suggest.

Crash Mitigation

Have you investigated any crash where you concluded that an ADAS likely helped mitigate (lessen) the crash severity?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

Please think about the most recent crash you investigated where you concluded that an ADAS likely helped mitigate the crash severity. Approximately how many months ago did that crash occur?

Without providing identifying details, please describe the ADAS involved, the circumstances of the crash, and your approach for conducting the investigation.

Crash Contribution

Have you investigated any crash where you concluded that an ADAS likely contributed to the occurrence of the crash or made the crash more severe?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

Please think about the most recent crash you investigated where you concluded that an ADAS likely contributed to the occurrence of the crash or made the crash more severe. Approximately how many months ago did that crash occur?

Without providing identifying details, please describe the ADAS involved, the circumstances of the crash, and your approach for conducting the investigation.

Autonomous Vehicle

Have you investigated any crash involving an autonomous vehicle?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

Please think about the most recent crash you investigated involving an autonomous vehicle. Approximately how many months ago did that crash occur?

Without providing identifying details, please describe the autonomous vehicle involved, the circumstances of the crash, and your approach for conducting the investigation.

To what extent do you agree or disagree with the following statements?

	Strongly disagree	Somewhat disagree	Slightly disagree	Slightly agree	Somewhat agree	Strongly agree	Prefer not to answer
My ability to effectively investigate crashes would be enhanced if I received training about ADAS. * must provide value	○	○	○	○	○	○	○
I would like more training about ADAS and how drivers use them. * must provide value	○	○	○	○	○	○	○
I know where on a vehicle to look for sensors and cameras used by ADAS. * must provide value	○	○	○	○	○	○	○
I have a clear understanding of the difference between ADAS and Automated Driving Systems. * must provide value	○	○	○	○	○	○	○

To what extent do you agree or disagree with the following statements?

	Strongly disagree	Somewhat disagree	Slightly disagree	Slightly agree	Somewhat agree	Strongly agree	Prefer not to answer
I received formal training about how enter information into the Autonomous Vehicle Capability field on the Colorado Traffic Crash Report. * must provide value	○	○	○	○	○	○	○
I received informal training about how enter information into the Autonomous Vehicle Capability field on the Colorado Traffic Crash Report. * must provide value	○	○	○	○	○	○	○
The Autonomous Vehicle Capability field on the Colorado crash report form is sufficient for reporting ADAS related information. * must provide value	○	○	○	○	○	○	○
The method of reporting ADAS- related information on the Colorado crash report form needs to be improved. * must provide value	○	○	○	○	○	○	○
I understand the difference between Driver Assistance and Partial Automation. * must provide value	○	○	○	○	○	○	○
I understand the difference between Partial Automation and Conditional Automation. * must provide value	○	○	○	○	○	○	○
I understand the difference between Conditional Automation and High Automation. * must provide value	○	○	○	○	○	○	○
I understand when it is appropriate to indicate that	○	○	○	○	○	○	○

"Driver Ceded Control of Vehicle" on the Colorado Traffic Crash Report. * must provide value							
A new field should be added to the Colorado Traffic Crash Report for the investigator to enter the type of ADAS technology or technologies on the vehicle. * must provide value	○	○	○	○	○	○	○

Please rate your level of understanding for each of these ADAS technologies. Consider your understanding of their purpose, function, and limitations.

	1 Very Low	2	3	4	5	6 Very High	Prefer not to answer
Blind spot warning * must provide value	○	○	○	○	○	○	○
Forward collision warning * must provide value	○	○	○	○	○	○	○
Lane departure warning * must provide value	○	○	○	○	○	○	○
Automatic emergency braking * must provide value	○	○	○	○	○	○	○
Automatic emergency steering * must provide value	○	○	○	○	○	○	○
Lane keeping assist * must provide value	○	○	○	○	○	○	○
Adaptive cruise control * must provide value	○	○	○	○	○	○	○
Lane centering assist * must provide value	○	○	○	○	○	○	○
Active driving assist * must provide value	○	○	○	○	○	○	○

Consider the vehicles you drive regularly for work and for personal use. For each ADAS feature, select the response option that best reflects your personal experience with driving vehicles equipped with ADAS.

	Work Only	Personal Only	Both Work and Personal	No Vehicle(s)	Unsure	Prefer not to answer
Blind spot warning * must provide value	○	○	○	○	○	○
Forward collision warning * must provide value	○	○	○	○	○	○
Lane departure warning * must provide value	○	○	○	○	○	○
Automatic emergency braking * must provide value	○	○	○	○	○	○
Automatic emergency steering * must provide value	○	○	○	○	○	○
Lane keeping assist * must provide value	○	○	○	○	○	○
Adaptive cruise control * must provide value	○	○	○	○	○	○
Lane centering assist * must provide value	○	○	○	○	○	○
Active driving assist * must provide value	○	○	○	○	○	○

Has your personal experience with ADAS technologies in the vehicle you have driven for work or personal use influenced your ability to identify ADAS in the crashes that you investigate?

* must provide value

○ Yes
○ No
○ Prefer not to answer

Please explain how your personal experience with ADAS has influenced how you investigate crashes.

Have you sought information about advanced vehicle technologies on your own, i.e., as a consumer or for your own personal interest?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

Please describe what information you were looking for and where you looked.

Training Preference

Consider how you prefer to learn about new topics. Which method of training would be most effective for you to learn about ADAS?

* must provide value

- ○ In-person class
- ○ Virtual class
- ○ Online module
- ○ Pre-recorded videos
- ○ Printed materials
- ○ Other
- ○ Combination of methods
- ○ Prefer not to answer

ADAS Training

Have you received any formal training related to ADAS features?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

How many times have you received formal training about ADAS?

* must provide value

- ○ 1
- ○ 2
- ○ 3
- ○ 4+
- ○ Prefer not to answer

Please think about the most recent training you received. In what format was the training provided? Please select all that apply.

* must provide value

- [ ] In-person class
- [ ] Virtual class
- [ ] Online module
- [ ] Pre-recorded videos
- [ ] Printed materials
- [ ] Other
- [ ] Prefer not to answer

What type of agency or organization provided the training?

Do you think the most recent training was effective at increasing your knowledge of ADAS?

* must provide value

- ○ Not at all effective
- ○ Slightly effective
- ○ Somewhat effective
- ○ Very effective
- ○ Prefer not to answer

What topics did the most recent training cover?

Were there topics that were not included in the training that you think should have been?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

What are the topics that you think should have been?

Have you received any informal training or education (e.g., handouts) related to ADAS?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

Please think about the most recent time you received informal training or educational materials related to ADAS. What type of agency or organization provided the informal training or materials?

Do you think the informal training or educational materials were effective at increasing your knowledge of ADAS?

* must provide value

- ○ Not at all effective
- ○ Slightly effective
- ○ Somewhat effective
- ○ Very effective
- ○ Prefer not to answer

What topics were covered?

Were there topics that were not included in the training that you think should have been?

* must provide value

- ○ Yes
- ○ No
- ○ Prefer not to answer

What are the topics that you think should have been included?

APPENDIX G. OFFICER INTERVIEW GUIDE

Purpose

The purpose of this guide is to help the interviewer conduct the interview with the officer by outlining the interview topic areas and possible questions for the interview. Bold text indicates scripted portions and transitions for the interviewer. The questions shown may or may not be used for a particular interview. Questions may be modified or other questions that address the topic area may be used. The number and order of questions used during the interview will be dictated by the interviewee's responses. The topic areas for the interview include the officer's approach to conducting crash investigations, their approach to ascertaining the role the ADAS technologies may have played in contributing to or mitigating a crash, how the officers decide when to include ADAS-related information on the crash report, information related to training on ADAS technologies that the officer has received, and their understanding of the ADAS feature(s) on vehicles.

Test equipment

Before we begin the interview, I would like to introduce you to my colleague, [Name], who will be assisting me today. We need to perform a short test before we start the interview.

If subject does not have their camera on, **Do you have video capabilities?** *If so*, **Would you mind turning the camera on?**

If subject already has their camera on, **I can see that your camera is on and working. Thank you for doing that.**

We prefer to have a face-to-face conversation rather than using just audio and sometimes facial expressions can help us identify words if the audio is not clear for the transcription.

Once video comes up or subject indicates they do not have video capabilities, **We will now perform a short test. I will ask you a few questions, and I would like you respond, please.**

> *To the second researcher:* ***[Name], Please start the recording.***
>
> Interviewer: **What do you think of the weather today?**
>
> Interviewee: Response
>
> Interviewer: **Which season is your favorite season and why?**
>
> Interviewee: Response

To second researcher: **Ok, [Name], please stop the recording. Can you verify that everything is working?**

If there are issues with the recording or the transcription, try to make adjustments. If the subject has joined through computer audio, consider asking them call into Team with their phone.

If test is successful **Ok, thank you for helping us with that test. It looks like we can begin the interview.**

Interview

Thank you again for making the time to talk with us today. We want to learn about your approach to investigating crashes, especially when a vehicle involved in a crash may be equipped with advanced vehicle technologies. During our discussion today, you are encouraged to use examples from your crash investigations to illustrate your approach to investigating crashes. However, please do not share the identities of individuals or locations and do not provide dates of crashes. You can mention specific vehicle makes and/or models if they are relevant to your example(s). Does this request make sense to you?

During the interview, I will refrain from using your name to protect your confidentiality. If you happen to say someone's name, please know that we will redact it from the interview transcript. If you would like to skip a question, you can just say "pass" or "I'd prefer to not answer that question." If at any time you need a break, just let me know. You are the expert here, and we cannot do this project without the help of officers like you, so thank you for talking to us today. Do you have any questions before we start recording?

After addressing any questions, the second researcher will begin the recording.

We are going to begin the interview today with some questions about how you prefer to conduct crash investigations.

General crash investigation

I. How long have you been investigating motor vehicle crashes?
II. Can you please describe the training you received for completing a crash investigation?
III. Please describe your typical approach for conducting a crash investigation. Try to focus on the investigation phase and do not include information about arriving on scene and rendering aid to injured people.

Transition - **Thank you for sharing that with us. Now I would like to learn how you investigate crashes that involve passenger vehicles equipped with advanced vehicle technologies. These systems are often referred to as Advanced Driver Assistance Systems or by the acronym ADAS. These systems monitor the driving environment and may warn a driver of a potential collision, such as blind spot warning, lane departure warning, or forward collision warning; or they may provide intervention to avoid or mitigate a collision, such as lane keeping assist, automated emergency braking, or automated emergency steering; or they may provide driving control assistance when certain conditions are met, like adaptive cruise control, lane centering assist, or active driving assist. I only mentioned a few examples of each category of ADAS. There are many others, and they may be known by different names.**

ADAS crash investigation

I. How frequently do you consider Advanced Driver Assistance Systems or ADAS as a routine part of your crash investigation protocol?
II. (If Never or Rarely) Why don't you consider ADAS when investigating a crash?
III. What circumstances lead you to consider ADAS in your investigations? (Potential responses: Driver of vehicle told me they had an ADAS on the car, I noticed cameras or sensors on the exterior of the vehicle, Vehicle model year is relatively new)

IV. Where do you look for information about ADAS when conducting any crash investigation? (Potential responses: VIN look-up, owner's manual, event data recorder)
V. Please describe how you indicate on the crash report the presence of ADAS on the vehicle and impact of ADAS on the crash.
VI. Have you investigated any crashes where you concluded that an ADAS likely helped mitigate the crash severity?

   A. Please think about the most recent crash you investigated where you concluded that an ADAS likely helped mitigate the crash severity. Approximately how long ago did that crash occur?

   B. Without providing identifying details, please describe the ADAS involved, the circumstances of the crash, and your approach for conducting the investigation.

I. Have you investigated any crashes where you concluded that an ADAS likely contributed to the occurrence of the crash or made the crash more severe?

   A. Please think about most recent crash you investigated where you concluded that an ADAS likely contributed to the occurrence of the crash or made the crash more severe. Approximately how long ago did that crash occur?
   B. Without providing identifying details, please describe the ADAS involved, the circumstances of the crash, and your approach for conducting the investigation.

II. Have you ever investigated a crash involving an autonomous vehicle?

   A. Please think about most recent crash you investigated involving an autonomous vehicle. Approximately how long ago did that crash occur?

   B. Without providing identifying details, please describe the ADAS involved, the circumstances of the crash, and your approach for conducting the investigation.

Transition – Thank you for sharing that information with us. Is there anything else you'd like to share with out about your approach to investigating crashes involving ADAS [or automated vehicles]?

Next, we would like to learn more about how your investigation of ADAS technologies is represented in the [Iowa Crash Report Form/Colorado Traffic Crash Report].

ADAS technology and crash report form

I. What is your approach for including your consideration of ADAS technologies on the crash report?
II. (Iowa officers) Have you ever received formal or informal instruction about including ADAS on your crash reports?
III. (Iowa officers) If the Iowa crash report were revised to include a field for collecting information related to ADAS technologies, what would you recommend?
IV. (Colorado officers) Have you received any formal training about how enter information into the Autonomous Vehicle Capability field on the Colorado Traffic Crash Report? How about informal training?
   A. Please describe the training you received.
   B. How long ago was it?
   C. In what format was the training provided? (Possible responses: In-person, virtual class, online module or prerecorded videos, printed materials)
   D. Was the training effective?

   E. How could the training have been improved?
V. (Colorado officers) Do you understand the difference between the different levels of automation on the Traffic Crash Report? Driver Assistance, Partial Automation, Conditional Automation, and High Automation.
VI. (Colorado officers) Is the Autonomous Vehicle Capability field on the Colorado crash report form is sufficient for reporting ADAS related information? How could the form be improved?
VII. (All officers) Do you believe [more] training about how to include ADAS on the crash report would be beneficial?

Next, we would like to learn about any training about ADAS that you have received.

ADAS training and education

I. Have you received any formal training related to ADAS technologies?
   A. How many times have you received formal training about ADAS?
   B. Please think about the most recent training you received. In what format was the training provided? (Possible responses: In-person, virtual class, online module or prerecorded videos, printed materials, other)
   C. What topics did the most recent training cover?
   D. What type of agency or organization provided the training?
   E. Was the most recent training effective at increasing your knowledge of ADAS? Why or why not?
   F. Were there any topics that were not included that you think should have been? Which topics?
II. Have you received any informal training or educational materials such as handouts that included information related to ADAS technologies?
   A. Please think about the most recent time you received this training. What topics were covered?
   B. What type of agency or organization provided the materials?
   G. Were the materials effective at increasing your knowledge of ADAS? Why or why not?
   C. Were there any topics that were not included that you think should have been? Which topics?

Transition – Thank you for sharing that information with us. Now I would like you to think about your own personal experience with ADAS technologies. This could be on your patrol vehicle or your personal vehicle.

ADAS understanding and experience

I. Do you have any ADAS technologies on your patrol vehicle(s)? If so, please describe what they are and how you use them.
II. Do you have any ADAS technologies on the personal vehicle(s) in your household? Describe what they are and how you use them.
III. Have you sought information about ADAS on your own, i.e., as a consumer or for your own personal interest?
IV. Do you think your experiences using ADAS have influenced how you conduct crash investigations?

Thank you very much for making the time to speak with us today. We really appreciate you helping us to understand your experiences with ADAS in the context of crash investigations. Do you have anything else you would like to share with us?

Do you have any questions for us?

If you have any questions or think of anything else you'd like us to know, feel free to contact us by email. We sincerely appreciate your time and the insights you have shared with us.