Final Report

Public Education about Occupant Protection Technologies and Protecting Occupants with Disabilities

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16. Abstract

Occupant protection is the foundation of any traffic safety program. According to National Highway Traffic Safety Administration (NHTSA) estimates, improvements in vehicle safety have helped increase the number of lives saved annually from 115 in 1960 to 27,621 in 2012. Therefore, educating drivers about advanced new technologies in vehicle occupant protection is very important. However, these technologies are not useful or efficient unless drivers are aware of them and use them accordingly. The purpose of this project was first to comprehensively review all the technologies related to occupant protection and also all the technologies related to occupant protection for people with disabilities using all available websites and related articles. Overall, 26 active safety technologies and 8 passive safety technologies were found regarding general occupant protection technologies. Also, 19 technologies were found related to occupant protection for people with disabilities. Another goal of this project was to promote a culture of safety through public education and training about occupant protection technologies, especially for people with disabilities. To reach this goal, two educational webinars about available technologies that protect occupants and people with disabilities were held. In both webinars, the research team tried to emphasize the importance of occupant protection by providing facts about the safety of passengers and drivers during a crash and the potential severity of injuries. The first webinar was held on April 15, 2022. The general occupant protection technologies in this webinar were categorized into two main categories: 1. Active Safety Technologies (e.g., Blind Sport Detection, Forward Collision Warning, etc.); and 2. Passive Safety Technologies (e.g., Airbags, Seatbelts, Belt bags, Child Safety Seats, etc.). In the end, a summary of the technologies was presented to the audience. Moreover, a section was dedicated to Q&A with the audience. Overall, 24 people joined the webinar. Some of the audience expressed their feelings about learning more about "child safety seats" and other new safety technologies. Moreover, some participants mentioned that the webinar introduced them to new technologies such as backseat airbags, belt bags, and turn assist. Moreover, to educate Maryland drivers about the advantages of new occupant protection technologies, an informative fact sheet was developed by the research team and distributed online and through social media. The second webinar was held on September 16, 2022, and focused on occupant protection technologies for people with disabilities. The first section of the webinar was a review of all the general occupant protection technologies that were presented in the first webinar. The second part of the webinar was about occupant protection for people with disabilities. First, some facts about the challenges that people with disabilities face in transportation were

mentioned. Then, occupant protection technologies for people with disabilities were categorized into four main sections: 1. Safety Technologies for Visual Impairment Drivers (e.g., bioptic glasses, AV cars, etc.); 2. Safety Technologies for Hearing Impairment Drivers (Audio-Tactile Conversion, Audio-Visual Conversion, etc.); 3. Safety Technologies for Physical Impairment Drivers (hand controls, steering, handicap accessible vehicles, etc.); and 4. Smartphone Applications that Help Drivers with Disabilities (e.g., Wheelmap, FuelService, etc.). In the end, a summary of all the technologies was presented to the audience. Again, a section was dedicated to Q&A with the audience. Overall, 44 people joined the webinar. Some of the audience expressed their feelings about learning more in-depth about "Waymo AV cars" and some additional new safety technologies.			
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LIST OF ACRONYMS

MHSO	Maryland Highway Safety Office
NHTSA	National Highway Traffic Safety Administration
LDW	Lane Departure Warning
LKA	Lane-keeping Assist
BSD	Blind Spot Detection
HUD	Head-Up Display
AFS	Adaptive Front-Lighting System
HBC	High Beam Control
RVM	Rear Vehicle Monitoring System
FCW	Forward Collision Warning
AEB	Automatic Braking System
BA/BAS	Brake Assist/ Brake Assist System
ABS	Anti-lock Braking System
ESS	Emergency Signal System
ESC	Electronic Stability Control
ISA	Intelligent Speed Adaptation
ACC	Adaptive or Autonomous Cruise Control
TPMS	Tire Pressure Monitoring Systems
DMS	Driver Monitoring System
NVS	Night Vision System
BIS	Belt-in-Seat
EPP	Electronic Pedestrian Protection System
CSS	Child Safety Seats
WLP	Whiplash Protection
CDC	Center for Disease Control and Prevention
AVC	Audio-Visual Conversion
ATC	Audio-Tactile Conversion

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ABSTRACT

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Keywords: Occupant Protection, Occupant Protection for People with Disabilities

1. INTRODUCTION

Motor vehicle crashes have been one of the leading causes of death in the United States over the past thirty years (*1*). Occupant Protection (OP) is the foundation of any sound traffic safety program (*2*). In the event of a crash, safety equipment intended to protect motor vehicle occupants is referred to as "occupant protection" (*3*). Vehicle safety has changed drastically over the years, and today newer cars are safer than ever before. All car manufacturers have been improving the safety of their vehicles by adding various cutting-edge safety features. According to NHTSA estimates, improvements in vehicle safety have helped increase the number of lives saved annually from 115 in 1960 to 27,621 in 2012. Between 1960 and 2012, these enhanced safety measures collectively prevented approximately 600,000 deaths (*4*).

However, the widespread and increasingly advanced technologies designed to protect vehicle occupants are not necessarily protective if the drivers are not aware of them and do not use them. Moreover, although most drivers in the U.S. follow these safety measures on every trip, there are still millions who do not (*1*).

Therefore, the first problem is that the new occupant protection technologies cannot be used efficiently unless the public is aware of and educated about them. Moreover, there are occupant protection technologies that have been designed specifically to protect occupants with disabilities. These technologies have not received enough attention, and most people are not aware of them. Hence, the second problem is that there is a lack of awareness about technologies that have been designed to protect occupants with disabilities.

1.1. Goal and Objectives

The main goal of this study is to promote a culture of safety through public education and training about occupant protection technologies, especially those that protect occupants with disabilities. To achieve this, the following objectives will be undertaken:

- Conduct a holistic study on existing literature materials on available technologies that protect occupants, as well as technologies that protect occupants with disabilities.
- Organize and host two educational occupant protection webinars. This project classified all collected technologies and cell phone apps and developed materials for educational webinars about occupant protection and protecting occupants with disabilities. Additionally, all technologies that can protect occupants with disabilities were classified into different types of disabilities.

2. OCCUPANT PROTECTION TECHNOLOGIES

In the case of a crash, the occupant protection system reduces the forces acting on the occupants as much as possible (*5*). The purpose of both passive and active safety technologies is to keep occupants safe. Collisions and accidents can be avoided by employing active safety systems. Passive safety features, on the other hand, are designed to reduce the severity of an accident (*6*).

2.1. Active Safety Technologies

Active safety technologies or "Primary Safety Systems" include a set of features that are designed to avoid and reduce the risk of a crash. These technologies can be activated by the driver or can be automatically activated (*7*). Connected vehicle (CV) technology also aims to improve drivers' situational awareness through audible and visual warnings, thus reducing the likelihood of crashes caused by human error (*8*). Recent studies have shown that connected vehicles (CVs) can help improve traffic mobility and safety while saving energy and reducing emissions (*9*).

2.1.1. Lane Departure Warning Systems and Prevention

A Lane Departure Warning System prevents cars from crossing into other lanes. This technology helps distract drivers from lane drifting. In addition, more lane deviations and crashes occur during texting (*10*). The technology can also assist the driver in avoiding gutters and drains in some cases (*11*). There are now three major forms of lane departure warnings: lane departure warning, lane-keeping assist, and Lane centering assist (*12*).

2.1.1.1. Lane Departure Warning (LDW)

This technology is a warning-only feature. The vehicle warns the driver if it is drifting near or over the lane marking, and the driver must act by steering the vehicle back to the middle of the lane. Also, if there is no lane marking, this feature does not work (see **Figure 1**) (*12*).

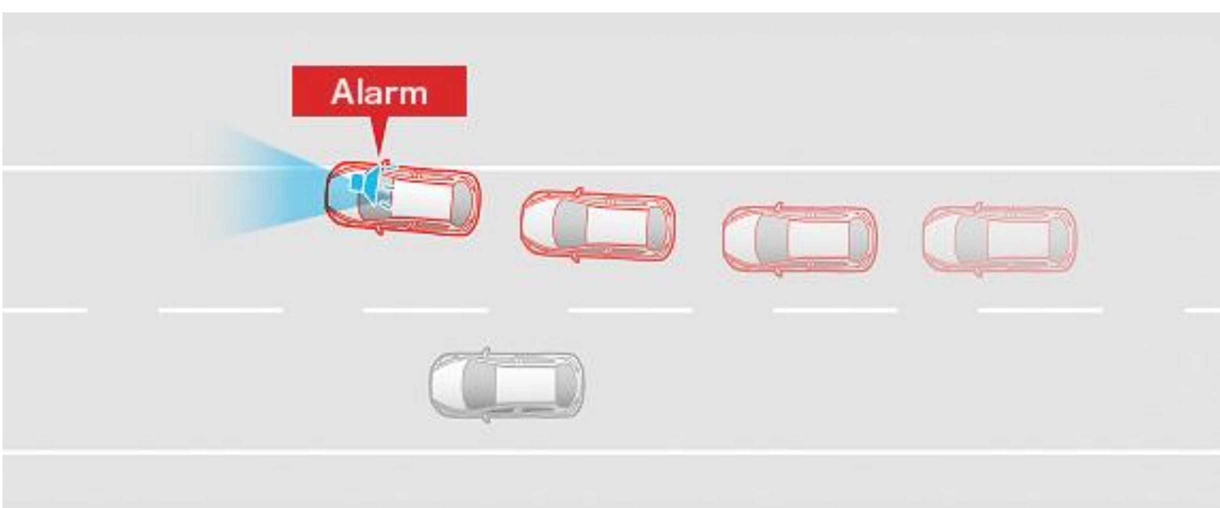

FIGURE 1 Lane Departure Warning (*13*)

2.1.1.2. Lane-keeping Assist (LKA)

Lane-Keeping Assist is like a Lane Departure Warning System. However, it also helps the driver to stay in the right lane by steering the car for up to 40 seconds (*11*). This is useful if the driver lets the vehicle drift too far (see **Figure 2**). The vehicle then steers itself away from the lane marking. It is also called a lane-keeping system, lane assist, side assists (Audi), lane departure alert with steering assist (Toyota), or lane departure prevention (LDP is sometimes applied to lane centering assist as well) (*12*).

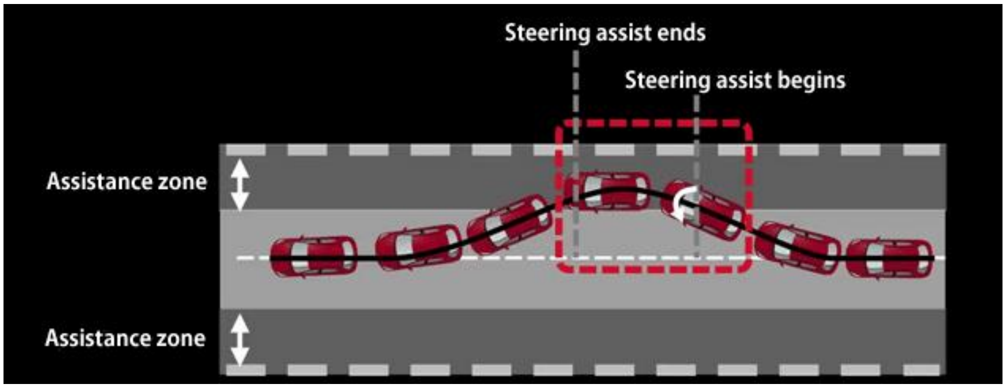

FIGURE 2 Lane Keeping Assist in Action

2.1.1.3. Lane Centering Assist

Lane centering assist is the newest form of lane departure warning system. Lane centering assist seeks to maintain the vehicle in the current lane. It works if the vehicle detects that you are holding the steering wheel lightly and that the turns aren't too sharp (*12*).

2.1.2. Blind Spot Detection (BSD)

Blind spot detection and lane departure warnings are often bundled in a package. This system actively monitors the blind spot over the shoulder and alerts the driver with a warning light when a threat is detected (*11*). Sonar or radar sensors that look back and to the side are used in blind spot detection. It warns the driver when a vehicle approaches quickly into the driver's blind area (see **Figure 3**) (*12*).

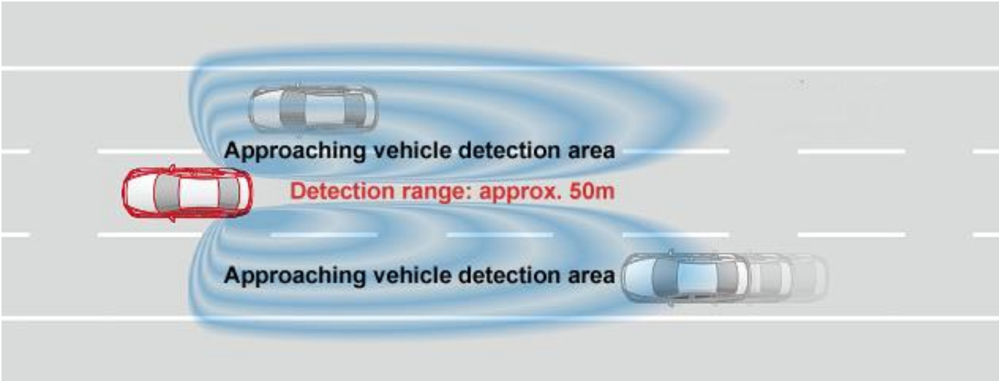

FIGURE 3 Blind Spot Detection (*14*)

2.1.3. Head-Up Display (HUD)

The head-up display is a device that projects an image directly under the driver's line of sight onto the vehicle's windshield or a panel. Although it is primarily a tool for gathering information, it is also a safety feature. It delivers a variety of information without requiring the driver to look away from the road. There are different types of Head-Up Displays: (*15*)

2.1.4. Adaptive Front-Lighting System (AFS)

The Adaptive Front-Lighting System (AFS) improves light distribution from the headlights based on driving conditions (see **Figure 7**). The device directs the low-beam headlights in the direction the driver desires to travel based on vehicle speed and steering input (*16*).

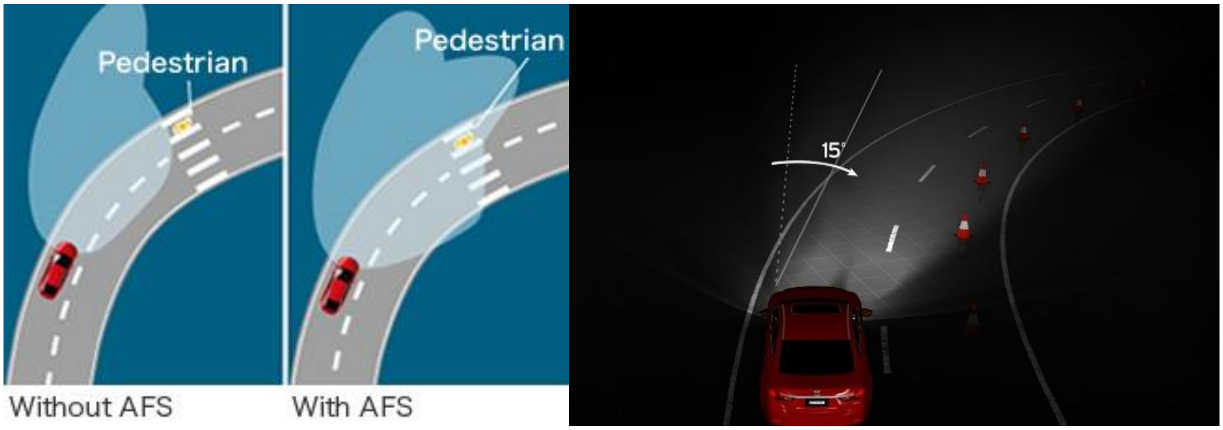

FIGURE 7 How Adaptive Front-Lighting System Works (*16*)

2.1.5. High Beam Control (HBC)

High Beam Control is combined with the Adaptive Front-Lighting System (AFS) in low-light conditions to detect incoming and preceding vehicles and automatically shift between high and low lights, making it easier for the driver to see threats (see **Figure 8**) (*17*).

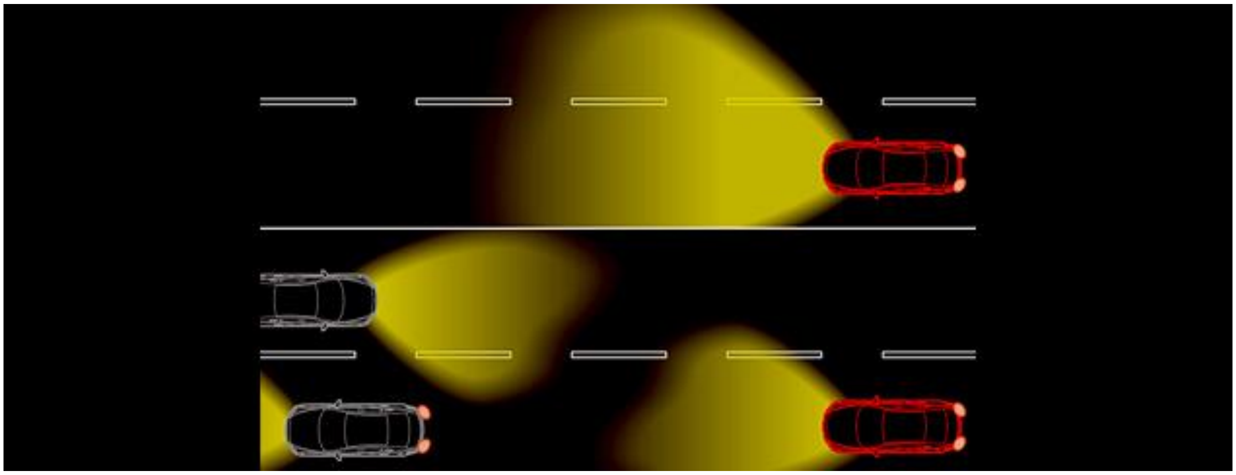

FIGURE 8 High Beam Control

2.1.6. Adaptive LED Headlights

Adaptive LED headlights are more efficient than conventional lights. The standard LED headlights do not adapt to the vehicle's speed, road configuration, or incoming traffic. However, both beam phases (short and high) of adaptive LED headlights rely exclusively on diodes to illuminate the road, and they may actively adjust themselves based on road conditions, approaching traffic, and vehicle speed (see **Figure 9**) (*18*).

FIGURE 9 MBW Adaptive LED Headlights

2.1.7. Rear Vehicle Monitoring System (RVM)

The Rear Vehicle Monitoring System (RVM) measures the distance between vehicles approaching from behind or in neighboring lanes using a quasi-milliwave radar installed on the rear bumper (see **Figure 10**). If there is a risk of a crash when changing lanes, it alerts the driver with an alarm and a warning signal (*19*).

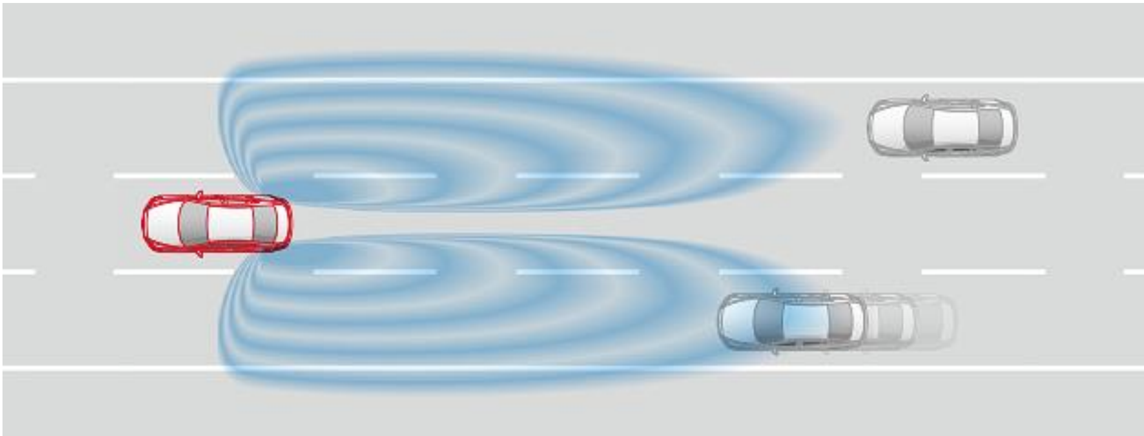

FIGURE 10 Rear Vehicle Monitoring System (*19*)

2.1.8. Pre-Collision System

The Pre-Collision System is a state-of-the-art safety feature by TOYOTA that can detect objects in the drivers' path and alert them when it is time to brake using a front-facing camera and laser. It may even autonomously bring the vehicle to a complete stop if necessary (*20*).

2.1.9. Collision Warning/Avoidance System

A collision avoidance system, also known as a driver assistance system, is a safety technology that was developed to avoid or reduce the severity of an accident seconds before it happens. Once a collision has been identified, these systems can inform the driver by sound or light to avoid the accident (see **Figure 11**). There are different types of Collision Avoidance Systems: the Forward Collision Warning System (FWC), Pedestrian Detection System, and Automatic Braking System (*21*).

FIGURE 11 Collision Avoidance System

2.1.9.1. Forward Collision Warning (FCW)

The Forward Collision Warning system is a cutting-edge safety device that keeps track of a vehicle's speed, the speed of the vehicle in front of it, and the distances between them. The FCW will warn the driver if the driver gets too close to the speed of the rear vehicle, but it will not apply the brakes automatically (see **Figure 12**) (*11*, *21*).

FIGURE 12 Forward Collision Warning System (*22*)

2.1.9.2. Pedestrian Detection System

Pedestrians and cyclists account for approximately a quarter of all fatalities on the road. A pedestrian detection system employs sensors to detect human movement on the road, such as cyclists or jaywalkers, with the hope of assisting drivers in spotting a moving item before it is too late (*21*).

2.1.9.3. Automatic Braking System (AEB)

The vehicle will inform the driver if there is a slowdown or a stop in traffic ahead. If the driver does nothing, the brakes will gradually slow the vehicle down (*11*). Some automated emergency braking (AEB) systems apply just a fraction of the braking force to give the driver more time to intervene, while others pump the brakes until the vehicle comes to a complete stop (see **Figure 13**) (*21*).

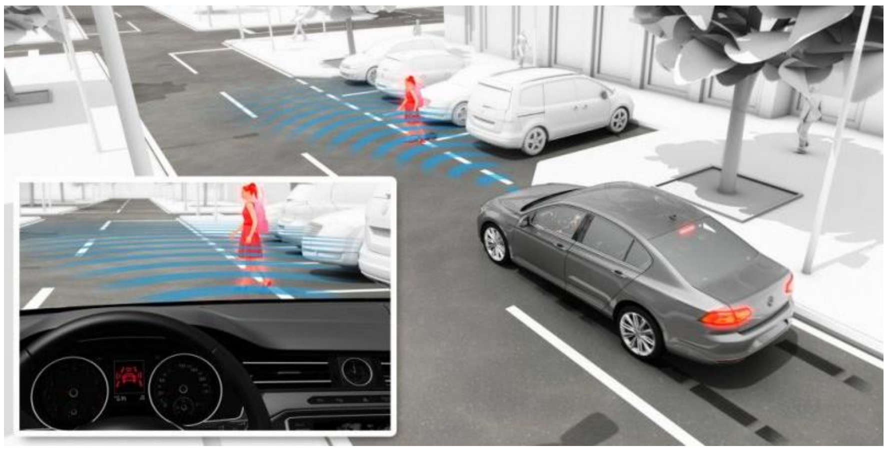

FIGURE 13 Volkswagen Pedestrian Detection System (*23*)

2.1.10. Brake Assist (BA/BAS)

According to studies conducted by vehicle manufacturers, most road accidents could have been prevented if the driver had hit the brakes promptly and with more force after realizing the danger (see **Figure 14**). Therefore, vehicle manufacturers implemented brake assist, an electronic system to help drivers avoid injury in such situations (*24*).

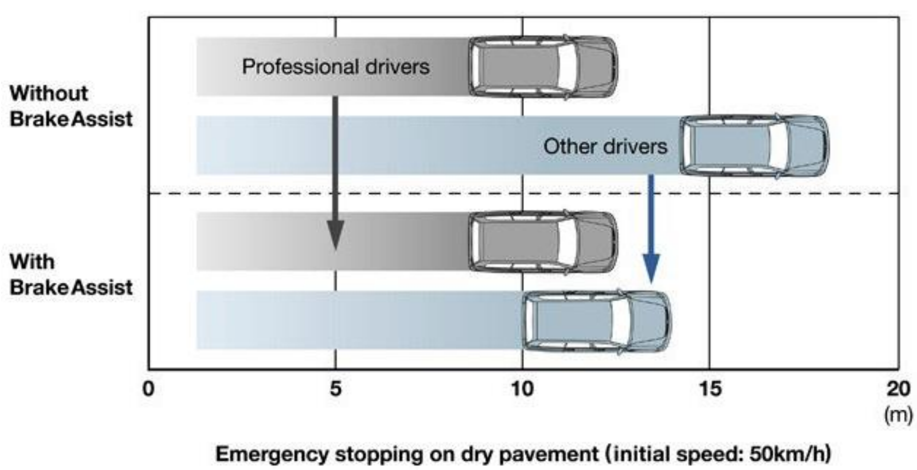

FIGURE 14 Advantages of Toyota Brake Assist

2.1.11. Anti-lock Braking System (ABS)

The Anti-lock Braking System is also known as the Anti-skid Braking System. An anti-lock braking system prevents any "wheel-lock" when the driver suddenly applies the brakes to a high-speed vehicle. Therefore, the driver will not lose control over the vehicle and prevent a crash (*25*).

2.1.12. Emergency Signal System (ESS)

This technology is intended to communicate the message of an emergency brake stop to the vehicle following closely behind (*26*). If the driver unexpectedly stops while driving at a fast speed, the Emergency Signal System (ESS) triggers the warning lights to flash. This helps avoid crashes by alerting oncoming traffic that the vehicle is braking hard. To minimize rear-end crashes, the danger lights switch to a regular flashing speed when the vehicle comes to a complete stop (see **Figure 15**) (*27*).

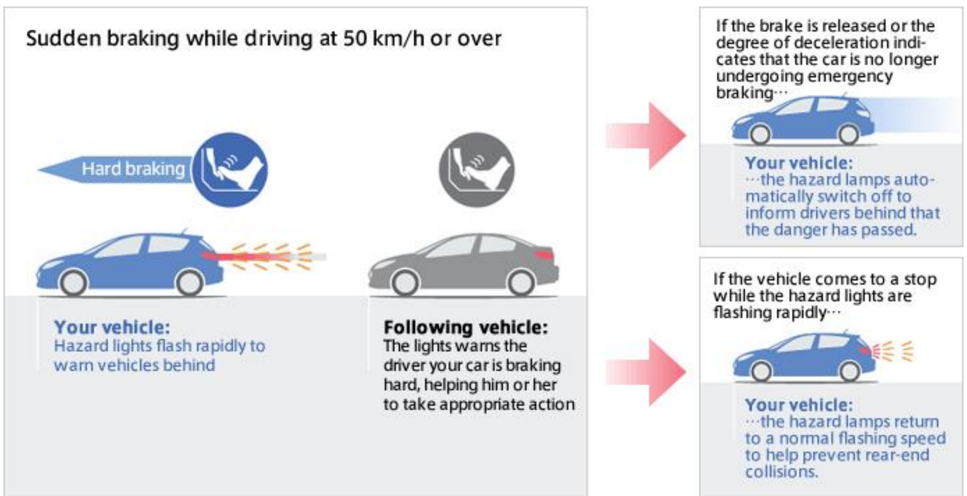

FIGURE 15 Emergency Signal System (*26*)

2.1.13. Electronic Stability Control (ESC)

ECS is an intelligent safety system that can anticipate the driver's intentions. It aids the driver in maintaining wheel trajectory by applying brakes to individual wheels. Second, during critical maneuvers, it may adjust the engine performance (see **Figure 16**). The main goal, however, is to improve vehicle stability. This technology offers additional benefits compared to ABS systems since it is capable of predicting the vehicle's driving behavior (*28*).

FIGURE 16 Electronic Stability Control (*29*)

2.1.14. Intelligent Speed Adaptation (ISA)

Intelligent Speed Adaptation (ISA) helps drivers stay within the speed limit. A worldwide navigation satellite system, such as GPS, is linked to a speed zone database, allowing the vehicle to "know" its position as well as the speed restrictions on that particular route. If the vehicle exceeds the speed limit, the ISA system offers visible and aural feedback to the driver (see **Figure 17**) (*30*).

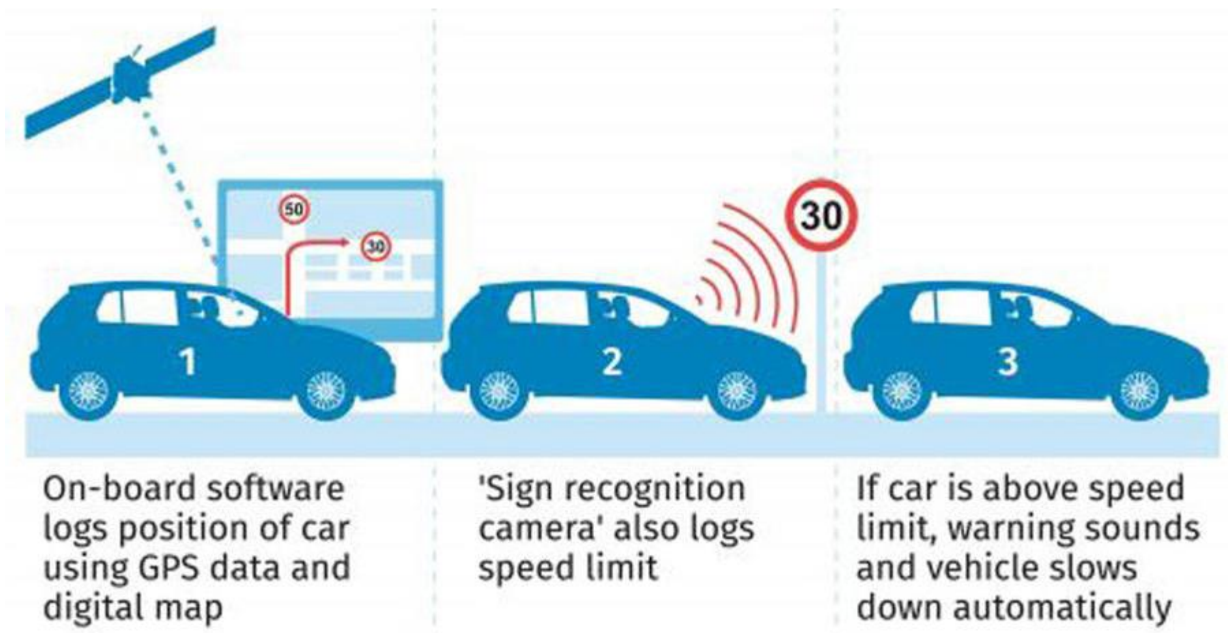

FIGURE 17 How Intelligent Speed Adaptation Works (*31*)

2.1.15. Adaptive or Autonomous Cruise Control (ACC)

ACC is the next generation of cruise control. The driver can use Cruise Control to automatically maintain the desired speed. One of the best examples are HOV lanes (which are reserved for vehicles carrying more than two people (*32*)). Vehicles in HOV lanes travel at a constant rate, and drivers entering carpool lanes at a slower pace can lead to rear-end crashes (*33*). When traveling at a steady pace, this technique is useful since it considerably minimizes driver fatigue. All Cruise Control Systems get deactivated when the driver presses the brake or the clutch pedal (*34*). This system reacts to other drivers on the road, braking as necessary to keep pace with traffic (*11*).

2.1.15.1. Traffic Jam Assist

This technology is a subsystem of adaptive cruise control (ACC) or adaptive cruise assist. Traffic jam assist can take over some steering functions in vehicles with an automatic transmission in a speed range of 0 to 65 km/h (40.4 mph) on good-condition roads as long as traffic is flowing slowly. It orients itself to lane markers, roadside buildings, and other vehicles on the road by making moderate steering motions within system restrictions (see **Figure 18**) (*35*).

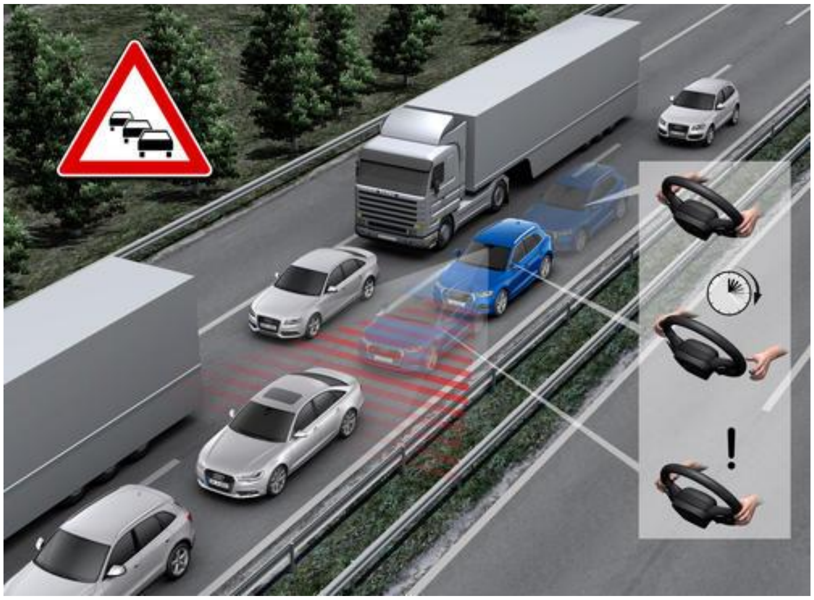

FIGURE 18 Traffic Jam Assist (*35*)

2.1.16. Tire Pressure Monitoring Systems (TPMS)

The tire pressure monitoring system (TPMS) in the vehicle is designed to alert the driver if one or more of the tires are considerably under-inflated, potentially resulting in dangerous driving conditions. The TPMS low tire pressure indication is a yellow sign in the shape of a tire cross-section (that resembles a horseshoe) with an exclamation point that glows on the dashboard instrument panel (see **Figure 19**) (*36*).

FIGURE 19 TIRE Pressure Monitoring Systems Sign on the Dashboard (*36*)

2.1.17. Driver Monitoring System (DMS)

In general, driver monitoring solutions or systems employ a single camera to track the driver's numerous facial expressions. Beyond just providing distraction alerts, a smart DMS may tailor the cabin to a specific user and estimate the driver's emotions (see **Figure 20**) (*37*).

FIGURE 20 Driver Monitoring System in Mazda (*38*)

2.1.18. Night Vision System (NVS)

Night Vision Systems improve a vehicle driver's sight in the dark by detecting objects beyond the reach of the vehicle's headlight. NIRs are used with either infrared light or thermographic sensors in Night Vision Systems (NVS) to show the road ahead on the onboard screen. At night or in low-visibility circumstances, the technology enhances the range of vision (see **Figure 21**). More modern systems utilize software to highlight people or animals and offer a warning on the (heads-up) display (*39*).

FIGURE 21 Night Vision System (*40*)

2.1.19. Rear-Cross Traffic Alert

This technology allows the vehicle to reverse out of parking lots and driveways with more accuracy (*4*). Rear Cross Traffic Alert is intended to assist the driver in backing out of spaces where the driver may not be able to notice incoming traffic, such as those in parking lots. Rear cross traffic Alert looks for cars approaching from the right or left in two regions behind the driver (see **Figure 22**) (*41*).

FIGURE 22 Rear Cross Traffic Alert (*42*)

2.1.20. Road Sign or Vulnerable Road User Detection

Vehicles should be able to recognize numerous traffic signs, traffic lights, pedestrians, and other objects on the road as they become semi-autonomous. Identifying all of these will ensure that the vehicles take the required precautions and follow all traffic regulations (*37*).

2.1.21. Turn Assist

Turn assist uses radar sensors, the front camera, and, in certain versions, a laser scanner to monitor the road lane for incoming traffic. As soon as the driver activates the turn signal, monitoring begins. The system can intervene by applying the brakes to avoid colliding with an oncoming vehicle when turning left or right (see **Figure 23**) (*35*).

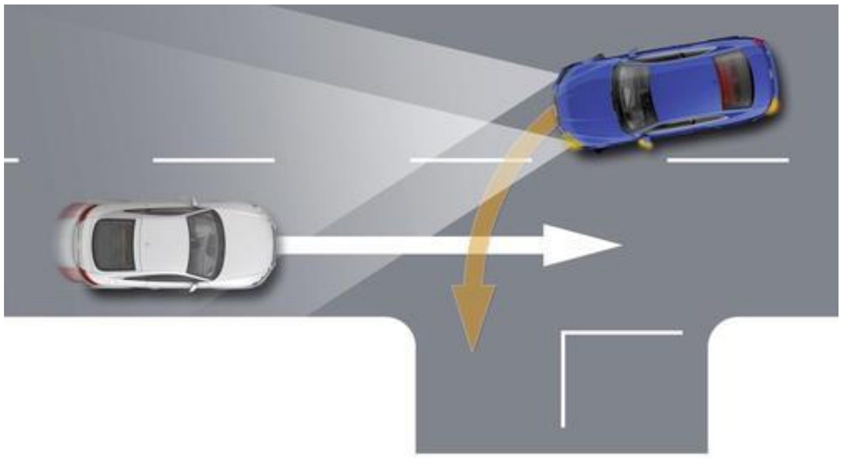

FIGURE 23 Turn Assist (*35*)

2.1.22. Crossing Assist

Crossing Assist detects dangerous cross traffic ahead of the vehicle and alerts the driver both visually and audibly (*35*). According to the Federal Highway Administration of the United States Department of Transportation, intersections account for more than half of all traffic crashes that result in injury or fatalities. Crossing Assist can also play a more active role in preventing crashes at crossings. If the driver ignores the warnings and continues to cruise into oncoming traffic, Crossing Assist will automatically apply the brakes to stop the vehicle (see **Figure 24**) (*43*).

FIGURE 24 Crossing Assist (*35*)

2.1.23. Hold Assist

When the vehicle is on regular inclines and descents in street traffic, this feature allows for simple drive-offs and prevents the vehicle from rolling. When the automobile is stopped for an extended period of time, the system automatically switches to the electromechanical parking brake when Hold Assist is engaged. This guarantees that the automobile will remain still even if the parking brake is not engaged (see **Figure 25**) (*35*).

FIGURE 25 Audi Hill Hold Assist (*44*)

2.1.24. Exit Warning

Exit Warning increases traffic safety in cities. This technology alerts passengers so that they do not open the doors if the vehicle has come to a halt and other vehicles or bikers categorized as critical are coming from behind. The exit warning uses the LED lights in the door panels. The LEDs flicker and become red in a potentially dangerous condition (see **Figure 26**) (*35*).

FIGURE 26 Exit Warning System (*35*)

2.1.25. 360 Cameras

The vehicle's four 360-degree cameras scan the nearby area and display any obstacles they find. Drivers may select from a variety of viewpoints that make parking and maneuvering easier. The MMI display shows a simulated overhead view that offers the driver an idea of the whole parking situation. The front and back panoramic views encompass almost 180 degrees, providing superior vision while exiting narrow parking spots, courtyard entrances, and complex crossings (*35*) (see **Figure 27**).

FIGURE 27 360 Cameras (*35*)

Moreover, some models have a virtual 3D view (see **Figure 28**). The driver may swivel and magnify the view of the vehicle and its surroundings using the touchscreen. There is also a view of the front or back tires, allowing the driver to back up to the curb (*35*).

FIGURE 28 Audi 360-degree cameras (*45*)

2.1.26. Rear Occupant Alert System

The device uses an ultrasonic sensor to monitor the back seats, which aids in the detection of children's movements. With a message on the center instrument cluster display, the system initially warns drivers to check the back seats before departing the car. After the driver exits the car, the system will sound the horn, flash the lights, and send a Blue Link warning to the driver's smartphone if it detects movement in the back seats (see **Figure 29**) (*46*).

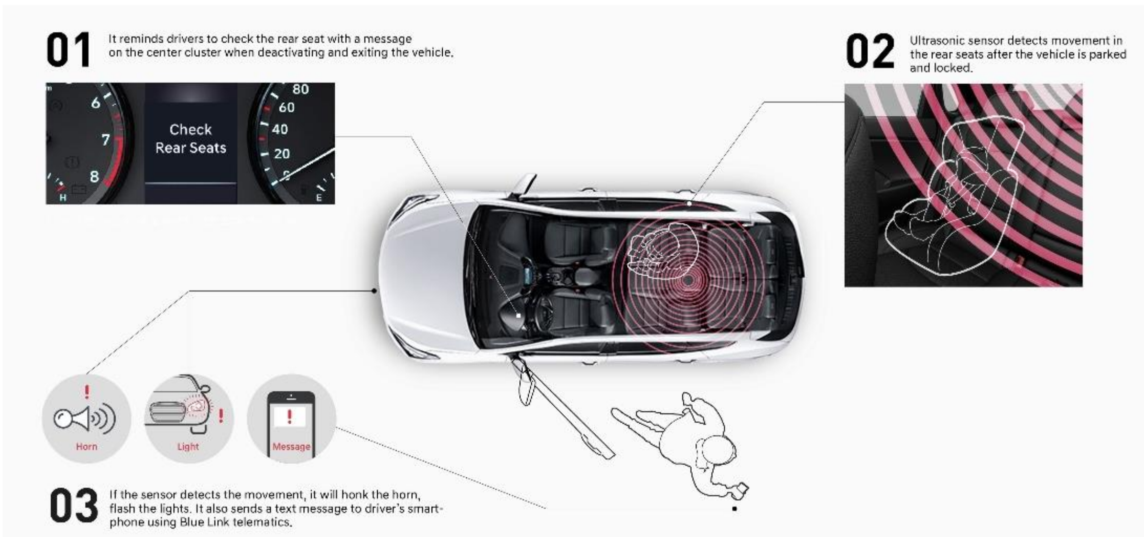

FIGURE 29 Hyundai Rear Occupant Alert System (*46*)

2.2. Passive Safety Technologies

Passive Safety Technologies help to reduce or decrease the severity of the crash and can be activated during or after the crash happens (*7*). These types of technologies are embedded into the vehicle and come into play after a certain event, like a crash or rollover.

2.2.1. Airbags

An airbag inflates in case of a frontal crash of a vehicle and provides a cushion for the occupants in case of a crash, and prevents direct collisions with objects inside the vehicle. Airbag systems contain three main components: the bag, which is composed of thin nylon fabric and folds to fit within the steering wheel at the correct position; the sensor, which aims to deliver an inflation signal to the airbag in the event of a crash; and the inflation system, which performs the actual task of inflating the bag (*47*).

FIGURE 30 Mercedes S-Class First Rear-Seat Airbags

Rear-seat airbags that deploy from the back panels of front passenger seats are a significant safety innovation in the 2021 Mercedes-Benz S-Class (see **Figure 30**). This has never been done before in any other vehicle, mainly because of the tremendous engineering requirements. Front airbags are designed to deploy from a fixed point in relation to the front seats, filling the gap between the driver and front-seat passenger pretty much wherever the seats are raked to, but protecting rear-seat passengers presented a far greater challenge, according to Mercedes-Benz engineers (*48*).

2.2.2. Seatbelts

Seat belt use has been one of the most significant cultural transformations in the car industry in the U.S. and the world over the last several decades. Only 15% of individuals wore seat belts in the early 1980s. These figures have already grown to around 90%. One of the main reasons for this is that most countries have made seat belt use mandatory. Seat belt design has also improved over time as safety procedures in the vehicle industry have improved. The six different types of seat belts and how they protect passengers in an accident are described below (*49*).

2.2.2.1. Lap Belts

The lap belt is the oldest and most basic type of seat belt, and it is less common these days. It is a two-point safety belt that wraps over the rider’s hips and secures them in place. It is unable to sustain the entire body of passengers, as the upper part of the body is free to move forward. This makes the head and neck vulnerable to injury in the event of a collision (*49*).

2.2.2.2. Shoulder Belts

Shoulder belts, often known as sash belts, are another form of the two-point safety belt. It binds the body from shoulder to hip and holds the rider across the trunk. This belt was created with the goal of restraining the upper body and preventing the kind of injuries that might occur in car accidents. These belts are now extremely rare and can only be found in old model cars (*49*).

2.2.2.3. Three-Point Belts

By stretching over the passengers' bodies and laps, this belt binds them at three set locations. It stretches from one shoulder to the other hip, then over the lap to the opposite hip. Combining the safety characteristics of the shoulder and lap belts, it is the most common seat belt in modern cars (*49*).

2.2.2.4. Automatic Seat Belts

Automatic seat belts provide the same level of protection as three-point belts but with the added benefit of being more convenient. These belts were fashionable a few decades ago, but they are becoming less popular. When a vehicle with automatic seat belts starts, the shoulder belts automatically slide into position to secure the passenger (*49*).

2.2.2.5. Belt-in-Seat (BIS)

BIS-type belts are commonly used in convertibles and pillarless hardtops where there is no "B" pillar to connect the upper side of the belt. This design is well-known among vehicle manufacturers like Chrysler and Cadillac.

2.2.2.6. Five- and Six-Point Harness

The passenger is secured with a five-point harness that spans both shoulders and hips. There is also a belt that connects the legs. This sort of belt is more popular in child safety seats and racing cars. Two belts go between the legs in a six-point harness, and the five-point harness seat belt has the same connection points as the four-point harness seat belt (*49*).

2.2.3. Crumple Zones

Crumple zones are areas on cars that plastically deform following a collision, creating a "controlled crush." They improve passenger safety by collecting as much kinetic energy as possible through deformation, extending stopping time, and diverting any extra energy away from the vehicle's occupants (see **Figure 31**). Furthermore, the majority of the forces that could possibly affect the passengers are instead directed to crumple zones, reducing the forces acting on the occupants. The occupants are also housed in a high-strength cabin that is designed to protect them rather than crush them along with the rest of the car (*50*).

FIGURE 31 Crumple Zones in a Vehicle (*51*)

2.2.4. Belt-Bags

A Belt-bag is a combination of a seat belt and an airbag (see **Figure 32**). In other words, it is an airbag fitted to the seat belt. In case of a crash, the torso of passengers, particularly the rib cage, is subjected to significant force from seatbelts. The aim of belt bags is to reduce possible damage to the rib cage (*52*).

FIGURE 32 Mercedes-Benz New S-Class Belt-bag

2.2.5. Fuel Pump Kill Switch

The fuel pump shut-off switch is an electrical switch featured on some vehicles that have internal combustion engines. The fuel pump shut-off switch, also known as the inertia switch, is meant to turn off the fuel pump when it detects that the vehicle has come to an unusually abrupt or hard stop. The gasoline pump shut-off switch will deactivate the fuel pump in the case of an accident or collision where fuel lines or hoses may be damaged, stopping the flow and preventing fuel leaks from becoming a safety issue. If the switch is tripped, the switch normally has a reset button that will reactivate the gasoline pump (*53*).

2.2.6. Electronic Pedestrian Protection System (EPP)

Electronic Pedestrian Protection Systems are designed to reduce the severity of injuries sustained to pedestrians when they crash with a moving vehicle. The pedestrian is protected from the heat generated in the engine compartment by the lowering of the bonnet's upper end. It also enables the bonnet to function as a cushion between the pedestrian's body and the hard engine components (see **Figure 33**) (*54*).

FIGURE 33 Stages of EPP (*54*)

Volvo has taken this technology a step further by integrating pedestrian airbags. It also deploys an airbag. As a result, it gives pedestrians an extra cushion, protecting them from injury (see **Figure 34**) (*54*).

FIGURE 34 Pedestrian Airbag on Volvo V40 (*54*)

2.2.7. Child Safety Seats (CSS)

The appropriate use of child restraints (car seats, booster seats, and seat belts) is one of the most effective ways to avoid fatalities in a car accident (see **Figure 35**). There are a variety of kid safety seats available, as well as car seat installation techniques for fastening them to a vehicle. The usage of seat belt systems, lap belts, or lap and shoulder belts is one technique. LATCH, which stands for Lower Anchors and Tethers for Children, is another option. The LATCH mechanism is needed in nearly every car seat and most automobiles made after September 1, 2002. Both seatbelts and LATCH installation procedures should never be combined at the same time. Exceptions can only be made if the car seat owner's handbook clearly indicates that both should be used (*55*).

FIGURE 35 Car Seats (*56*)

2.2.8. Whiplash Protection (WLP)

The Whiplash Protection System (WHIPS) is meant to minimize the risk of whiplash injuries. When a rear-end collision occurs, WHIPS is triggered and tailored to the angle and speed of the crash as well as the characteristics of the colliding vehicle. When WHIPS is turned on, the front seat backrests and seat cushions shift backward and downward, repositioning the driver and front seat passenger. This movement aids in the absorption of some of the stresses that might cause whiplash (see **Figure 36**) (*57*).

FIGURE 36 Volvo Whiplash Protection System

2.3. Occupant Protection Technologies for People with Disabilities

2.3.1. What is Disability

Any physical or mental condition that makes it harder for the person with the condition to engage in particular activities or interact with the world around them is referred to as a disability. There are several different kinds of disabilities, according to the Center for Disease Control and Prevention (CDC): (*58*)

- Vision
- Movement
- Thinking
- Remembering
- Learning
- Communicating
- Hearing
- Mental health
- Social relationships

2.3.2. Transportation for People with Disabilities

According to the U.S. Census Bureau, 26% (one in 4) or close to 61 million people in the U.S. have some type of disability. These persons face unique difficulties in obtaining and using a variety of necessities because of their disability. Transport is one of those essentials (*59*).

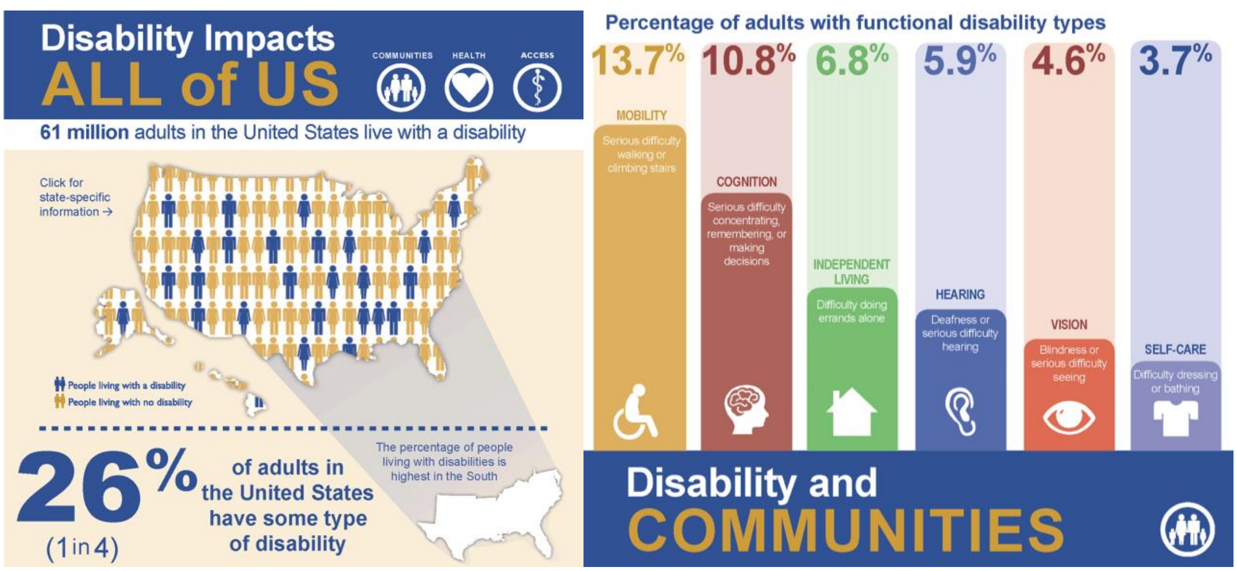

FIGURE 37 Disability Statistics

Transportation and mobility play key roles in the struggle for civil rights and equal opportunity in the disability community. Affordable and reliable transportation allows people with disabilities access to important opportunities in education, employment, health care, housing, and community life (*60*, *61*).

In order for people with disabilities to drive or ride in motor vehicles, these vehicles often need to be modified. For instance, hand controls, power seats, and wheelchair lifts are frequently installed to make it easier for paraplegics to enter and operate cars. About 383,000 vehicles have some kind of adaptive equipment fitted in them to accommodate a driver or passenger with a disability, according to the National Highway Traffic Safety Administration (NHTSA). As more people in the population get older and as the Americans with Disabilities Act (ADA) makes it easier for people with disabilities to access jobs, transportation, and leisure activities, the number of modified vehicles in the U.S. will rise (*62*).

Mobility-related problems have received most of the attention in studies of drivers with disabilities. Safety is essential to mobility, however, and there is relatively little information available about the safety of drivers who have disabilities (*63*).

2.3.4. Safety Technologies for Visual Impairment Drivers

2.3.4.1. Bioptic Glasses

Currently, specialized glasses (*64*) are offered for age-related macular degeneration and impaired vision. A person with limited vision has difficulty distinguishing objects like signs and approaching cars apart from background objects. The yellow and orange color of the glasses makes users' vision more contrast-rich (**Figure 38**) (*65*).

FIGURE 38 Bioptic telescopes in place on eyeglass lenses

One study examined bioptic safety based on critical events that occurred in naturalistic daily driving, and the results showed that the study failed to find any evidence suggesting that bioptic drivers were more prone to near-collisions than healthy drivers. Vision might be a less significant factor in this regard than cognition (*66*).

2.3.4.2. Autonomous Vehicles (AVs)

Although there is still work to be done, it is feasible that the development of self-driving vehicles will help to protect the safety of people with impaired vision (*65*). Recent developments have shown how the lives of blind and visually impaired people could be greatly improved by self-driving and semi-autonomous vehicles (*67*). Waymo, a self-driving technology development company, claims they are creating self-driving vehicles that will pick up passengers who are blind or visually impaired by sounding an audible signal when they arrive. They also include braille-marked control buttons and an app that updates the rider on the vehicle's progress (*65*). That technology is Waymo One, a fully autonomous ride-hailing service that has operated without an autonomous specialist in the front seat since 2020. Waymo One is serving riders over 18 years old in the Phoenix East Valley through its ride-hailing app (*68*).

Figure 39 Waymo for people with blindness or low vision

However, Self-driving cars will need to be modified for blind and visually impaired individuals to benefit more from them. For instance, commands for autonomous vehicles will probably be entered through a touchscreen interface. People who are blind or have visual impairments may have trouble finding the controls, which could be a problem. Many modern cars come equipped with voice assistant technology as a standard feature. This technology might be improved for use in self-driving automobiles by those who are blind or visually challenged (*67*).

2.3.4.3. Global Positioning Systems (GPS)

Cell phones might help by supplying traffic data (*69–71*), and Global Positioning Satellites (GPS) are now commonplace; a lot of drivers depend on voice instructions via a cell phone to guide them to the desired location, and that is making it easier and safer for those with low vision to maintain some independence while eliminating the need for using bioptic lenses. Some visually impaired drivers are now considering using GPS as an alternative so they can travel safely without bioptic telescopes and depend more on voice commands. It is necessary to assess potential users before deciding whether GPS is a better option than bioptic lenses, but this is undoubtedly a workable substitute for individuals with impaired vision who can still drive safely with a little more help (*72*).

2.3.4.4. Other technologies

Moreover, companies are attempting to make vehicles safer for the elderly and people who have vision problems. The most well-known improvements include lane departure warnings, which sound an alert if drivers are unable to notice whether they are straying out of their lane, and backup cameras, which can allow drivers to get a closer look at what is behind them. Auto-dimming rear-view mirrors, glare-reducing side mirrors, redesigned instrument panels with large numerals and letters, pre-collision systems, pedestrian and bicycle detection, parking assist, automatic high beams, road sign assist, rear-view cameras, and assistive technologies are helpful to blind and visually impaired drivers (*65, 67*).

2.3.5. Safety Technologies for Hearing Impairment Drivers

Drivers with hearing loss rely primarily on their senses of sight and touch (*73*). Technology that can improve the lives of hearing-impaired drivers is being introduced by car manufacturers. These technologies give hearing-impaired people a secure and enjoyable driving experience, enabling full “freedom of mobility.” (*74*)

2.3.5.1. Audio-Visual Conversion (AVC) and Audio-Tactile Conversion (ATC)

To alert hearing-impaired drivers to sounds outside their vehicle, these new technologies convert sounds into visual or tactile cues, either through a heads-up display (HUD) on the windshield or vibrations in the steering wheel. With the use of this innovative technology, drivers who have hearing loss will be able to drive more safely for both themselves and other motorists (*74*).

FIGURE 40 The Audio-Visual Conversion (AVC)

The AVC allows for safer driving by enabling communication with the external environment through visual portrayals of sound patterns, such as warning sounds of emergency vehicles, as pictograms on the head-up display (HUD). The steering wheel is also equipped with multi-colored LEDs, which indicate navigational information while driving (*73*). The ATC transfers the sound data into vibrations through the steering wheel, notifying the driver of information about external environments, such as distance from obstacles (*73*).

To showcase the technology, Hyundai Motor Group (HMG) unveiled the "Quiet Taxi" promotional video, which aims to inspire optimism in drivers with hearing loss. The value of "freedom of mobility" was emphasized in the campaign video and technology itself, showing Hyundai's efforts to make it possible for those who are hard of hearing about operating vehicles safely and freely. Hyundai also created a program to facilitate communication between hearing-impaired drivers and passengers as part of its objective (*73*).

FIGURE 41 The Quiet Taxi

Sadly, nothing comparable has been done with other manufacturers, particularly those in the U.S. There are several useful design elements already in existence. Subaru, for instance, makes use of EyeSight, which helps with lane changes and traffic flow. Both sound and light are used to achieve this. Nowadays, many vehicles come with optional collision-avoidance systems. This function, which lets your vehicle "see" other cars or pedestrians, predict crashes, and respond appropriately, is a perfect illustration of universal design because it benefits all drivers. This adds an additional degree of protection because many hearing drivers likely have their music too loud to hear outside noises (*75*).

2.3.5.2. Vehicle Modifications

One aftermarket modification designed to aid those with impaired hearing is an alert that lets the driver know when their turn signal is still on. Another lets the driver know when emergency sirens are going off nearby. These add-ons will not come from the factory, meaning drivers will need to go to find a specialist that installs these devices (*74*).

Another modification provides the driver with panoramic views of their surroundings. Drivers with hearing impairment can make up for their hearing loss by using their other senses, in this example, sight. On the road, keeping an eye out for what is in front of you is simple enough, but keeping an eye out for what is behind you or on either side may be more challenging. Hearing impaired drivers can obtain panoramic side and rear-view mirrors, which have a far wider field of view than a regular mirror, to combat this (*74*).

2.3.5.3. Other Technologies

Students from Indonesia's Bandung Institute of Technology (ITB) have created a device that will improve the safety of drivers with hearing impairments. According to a recent press release, Avion or Audio to Vibration will be giving the hearing impaired a safer and more secure driving experience. The device can be likened to a hearing aid for driving as it transforms the horn sound of another vehicle into vibrations that will alert the driver who has a hearing impairment (*76*).

2.3.6. Safety Technologies for Physical Impairment Drivers

The independence of those with disabilities mobility has improved significantly in recent years, whether they are visible or invisible. Many individuals who have physical disabilities own and operate vehicles. Below are some examples of equipment that people with physical impairments can use while driving: (*77*)

2.3.6.1. Hand controls

If a driver cannot use foot pedals at all, different types of hand controls can be fitted on an automatic car.

FIGURE 42 Hand Controls

2.3.6.2. Mirrors

A panoramic rear-view mirror can be a helpful tool to view blind spots if an individual has limited neck movement. Stick-on 'blind spot' mirrors extend what can be seen in traditional door mirrors.

FIGURE 43 Mirrors

2.3.6.3. Seats

Seats or platforms that move in and out of the vehicle can help a person get into the driver's seat.

FIGURE 44 Seats

2.3.6.4. Steering

The effort required to use the steering wheel or brake can be altered if a driver has difficulty using these controls.

FIGURE 44 Steering

2.3.6.5. Occupational Therapist

An occupational therapist can provide a prescription for a driver with disabilities recommending the use of specialized driving equipment and in-vehicle training. The prescription is taken to a vehicle modifier for equipment installation in the driver's personal vehicle.

2.3.6.6. Handicap Accessible Vehicles

2.3.6.6.1. Mobility Wheelchair Vehicles

Every wheelchair user and caregiver deserve a choice when it comes to mobility solutions. Side-entry and rear-entry vehicle options provide the widest product portfolio for people with disabilities ***(78)***.

2.3.6.6.1.1. Side Entry

The side-entry conversion puts a ramp at the side door of the vehicle, allowing for ease of entry and seating in the middle of the vehicle ***(79)***.

FIGURE 45 Side Entry Vehicle

2.3.6.6.1.2. Rear Entry

The rear-entry wheelchair van provides an economically-friendly option that takes the worry out of parking with the ramp located at the rear of the vehicle (*79*).

FIGURE 46 Rear Entry Vehicle

2.3.6.6.1.3. Fold-Out Ramps

A fold-out ramp rests upright along the inside of the closed sliding door and can easily be deployed over a curb or manually operated if needed (*79*).

FIGURE 47 Fold-Out Ramps Vehicle

2.3.6.6.1.4. In-Floor Ramps

With an in-floor ramp, the ramp is stored under the floor of the vehicle. With no ramp in the doorway, passengers who do not use a wheelchair can easily enter and exit as well(*79*).

FIGURE 48 In-Floor Ramps Vehicle

2.3.6.6.2. Wheelchair tie-down and occupant restraint system

Four tie-downs, two in the front and two in the back, are necessary for a wheelchair to be transported in a car safely. Additionally, a three-point seat belt is required for everyone using the wheelchair. Anything less is simply not secure. A wheelchair is secured by using four tie-downs. Two in the front and two in the back. These can be webbing straps or retractors. Drivers also have the option of using electric reels instead of front tie-downs. Each tie-down (2) is attached to the wheelchair using wheelchair fixing (3), either a strap with tongue and buckle, a hook, or a karabiner. Each tie-down (2) is then attached to the vehicle floor using a floor fitting (1), either via a solo anchor, in a rail, or directly bolted to the floor. The occupant belt (4) consists of a shoulder belt and a lap belt. The occupant belt can share the floor fitting with one of the rear tie-downs or have its own. A shoulder belt does, however, require the attachment of the upper anchorage (or 3rd point) in the vehicle; this is usually in the form of a piece of rail known as a cant rail (*80*).

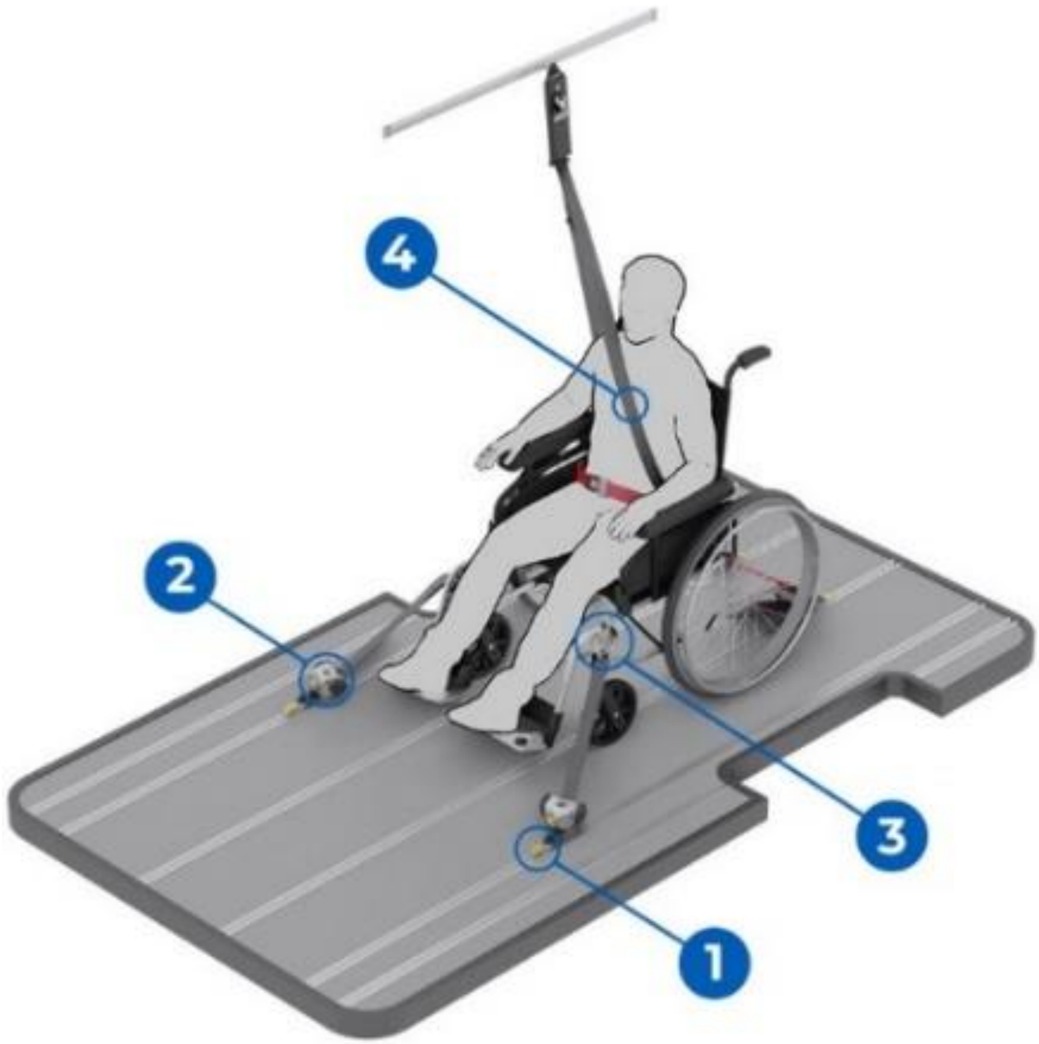

FIGURE 49 Wheelchair Tie-Downs

2.3.6.6.3. Kenguru

Kenguru is a company that is developing EV cars for wheelchair drivers. It is not the fastest electric car, nor does it have the longest range, but it does have one notable claim to fame. It is the world's first EV made specifically for wheelchair users. The Kenguru has just one door, which takes up the entire back panel of the vehicle. At the click of a button, the rear panel lifts, and a ramp automatically extends. When drivers turn on the ignition, the ramp retracts, and the door closes. The Kenguru has handlebars like a motorcycle in place of a typical steering wheel and pedals. Drivers can accelerate and brake with button controls instead of using their feet. Additionally, the automobile has a wheelchair-locking feature that prevents it from starting until the driver's wheelchair is properly stowed (*81*).

FIGURE 50 Kenguru EV Made for Wheelchair Users

2.3.7. Safety Technologies for Drivers with Cognitive Impairments

Drivers may sustain an injury or illness that results in cognitive changes. The changes may impact the driver's reaction time, ability to process the environmental stimuli, or ability to make the right judgments when driving. By performing clinical and on-road assessments, an occupational therapist can determine the impact of the cognitive changes on their patient's driving ability and make recommendations about their potential to do so in the future, including reintegration programs if appropriate. If an individual with a disability wants to start driving, an assessment with the Driver Assessment and Training team can help make informed decisions about equipment and training given a driver's medical status (*77*).

2.3.8. Smartphone Applications That Help Drivers with Disabilities

2.3.8.1. Wheelmate

Tells disabled drivers where the nearest disabled parking spaces are located (*82*).

FIGURE 51 Wheelmate App

2.3.8.2. Wheelmap

Allows users to find and share wheelchair-accessible places anywhere in the world (*82*).

FIGURE 52 Wheelmap App

2.3.8.3. Maps.me

With voice-controlled satellite navigation and offline and internet map apps, this technology virtually eliminates the possibility of getting lost. Users of apps like Maps.me can download a map of any location and then use it to navigate while offline. When driving, this is incredibly useful for disabled drivers (*82*).

FIGURE 53 Maps.me App

2.3.8.4. FuelService

This app helps disabled drivers find appropriate gas stations and get assistance refueling their vehicles. Refueling can be challenging for people who use wheelchairs and other disabled drivers, but FuelService aims to solve that challenge by showing you which gas stations have attendants who can help. Use the app to search for and choose a gas station from a list or map. The app will then contact the gas station to see if they can assist you. Once you arrive, the app notifies the attendant that you have arrived and shows you how long it will be before they come out to help. It even includes a rating system to help you choose gas stations that have provided good assistance to others (*83*).

FIGURE 54 FuelService App

3. OCCUPANT PROTECTION WEBINAR

The first webinar was held on April 15, 2022. **Figure 55** shows the outline of the webinar.

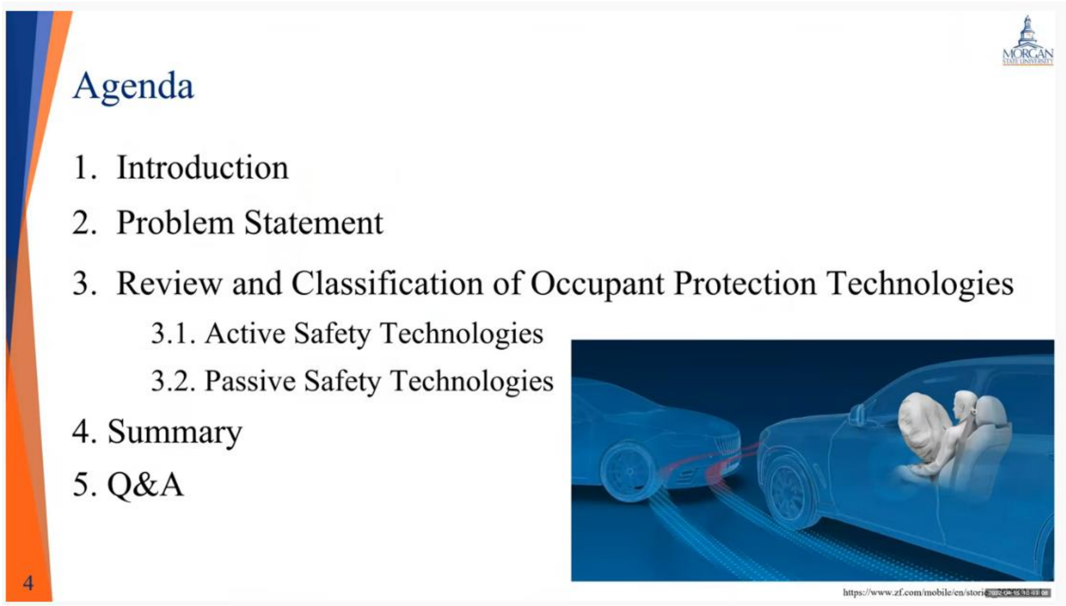

FIGURE 55 The Outline of the First Webinar

The webinar started with an introduction to occupant protection and occupant protection systems, explaining their importance, relevant facts, and associated technologies. The research team tried to emphasize that the occupant protection system greatly reduces the forces acting on occupants in the event of a crash and that the restraint mechanisms in the vehicle offer the best possible protection for the vehicle's occupants.

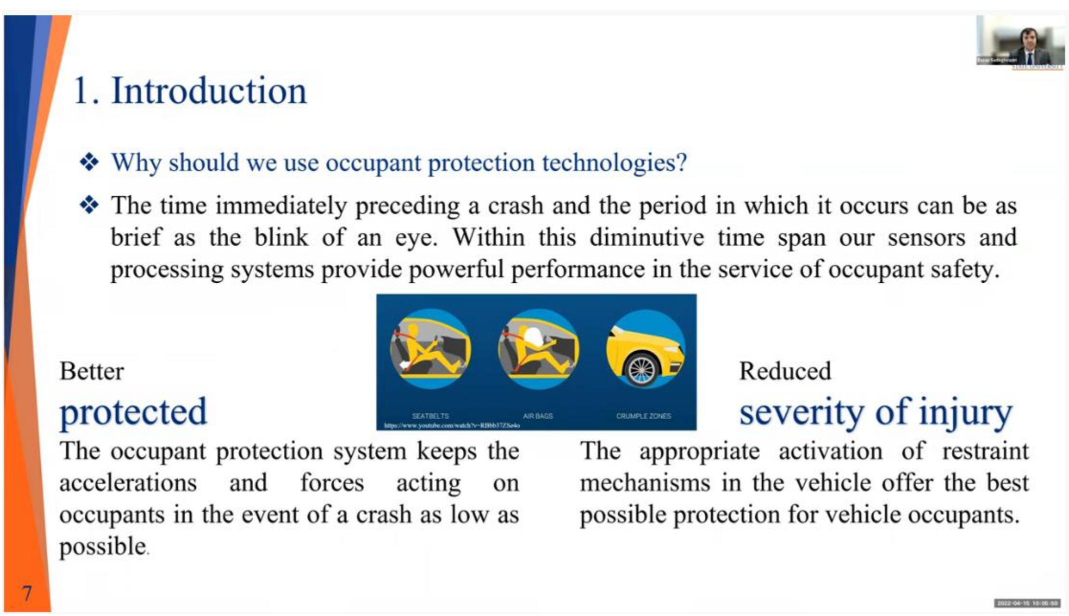

FIGURE 56 The Webinar's Introduction

Before explaining the technologies, the research teams discussed the categories of occupant protection systems, which are 1. Active safety technologies, and 2. Passive safety technologies.

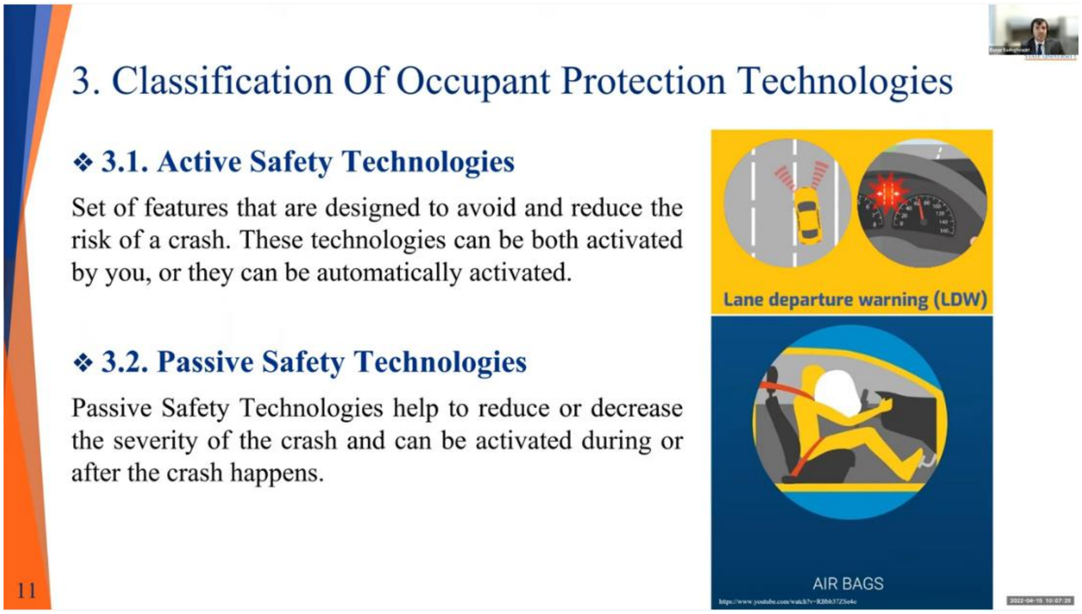

FIGURE 57 Occupant Protection Categories

Twenty-five active safety technologies were explained to the audience. Moreover, several informative videos and illustrations were presented to demonstrate how the specific technologies work.

FIGURE 58 Active Safety Technologies Example

Moreover, seven passive safety technology were also explained, and illustrations and videos were presented to help the audience understand how they work as well.

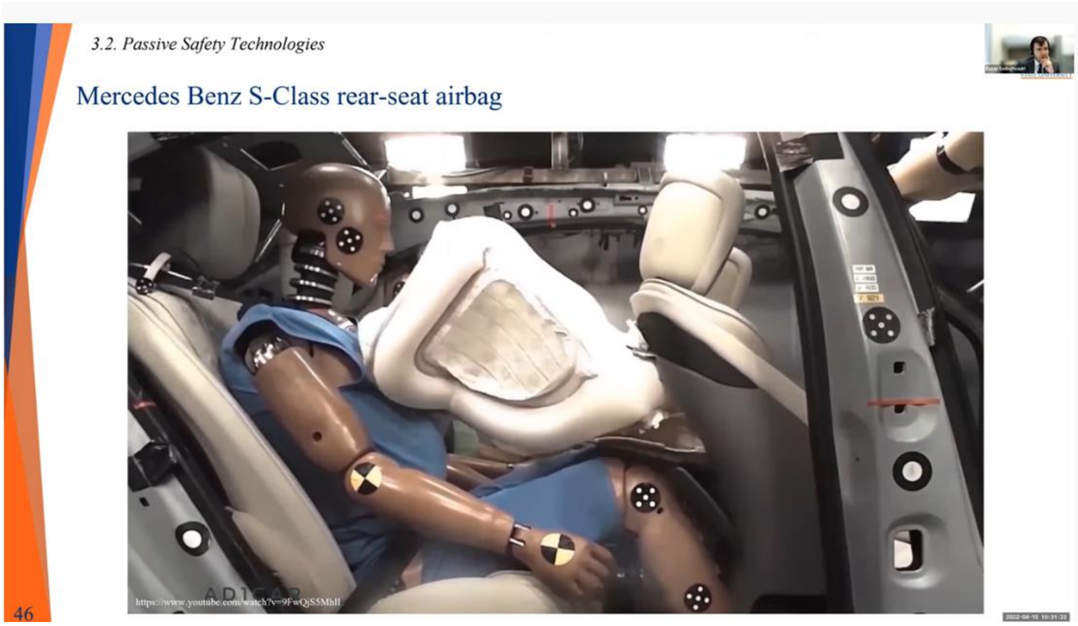

FIGURE 58 Passive Safety Technologies Example

In the end, a summary of all the technologies was presented to the audience. Moreover, a section was dedicated to Q&A with the audience. Overall, 24 people joined the webinar. Some of the audience expressed their feelings about learning more in-depth about "child safety seats" and some additional new safety technologies. Moreover, some participants mentioned that the webinar introduced them to new technologies such as backseat airbags, belt bags, and turn assist.

The link to the recorded webinar can be found here:

https://www.youtube.com/watch?v=UrPAZQaG9hM&list=PL3tN3CUqYVDDIA72q05CVukV3ClLUdDo2&index=4

3.1. Occupant Protection Technologies Factsheet

To educate Maryland drivers about the advantages of new occupant protection technologies, an informative fact sheet was developed by the research team after reviewing all the technologies in section 2 of this report and distributed online. The information in the fact sheet includes the link to the recorded occupant protection technologies webinar held on April 15, 2022. Moreover, all the active and passive safety technologies presented in the webinar were included in the factsheet as well (**Figure 59**).

Contact us for more information

The National Transportation Center (NTC) at Morgan State University advances U.S. technology and expertise in transportation, research, and technology transfer on the university level.

The NTC's current areas of research focus are connected and autonomous vehicles, transportation and traffic modeling, safety and distracted driving, and equity.

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For more information please contact:

Mansoureh.jeihani@morgan.edu
Eazaz.sadeghvaziri@morgan.edu
Rajah1@morgan.edu

Scan to watch the full webinar

Contact us know more about our upcoming webinar:
Technologies to protect occupants with different types of disabilities

About the webinar

Occupant protection technologies webinar was held in April 15, 2022.
The goal was to promote a culture of safety through public education and training about occupant protection technologies

National Transportation Center

1700 E. Cold Spring Lane
Baltimore, MD 21251
Phone: 443-885-3666

Occupant Protection Technologies

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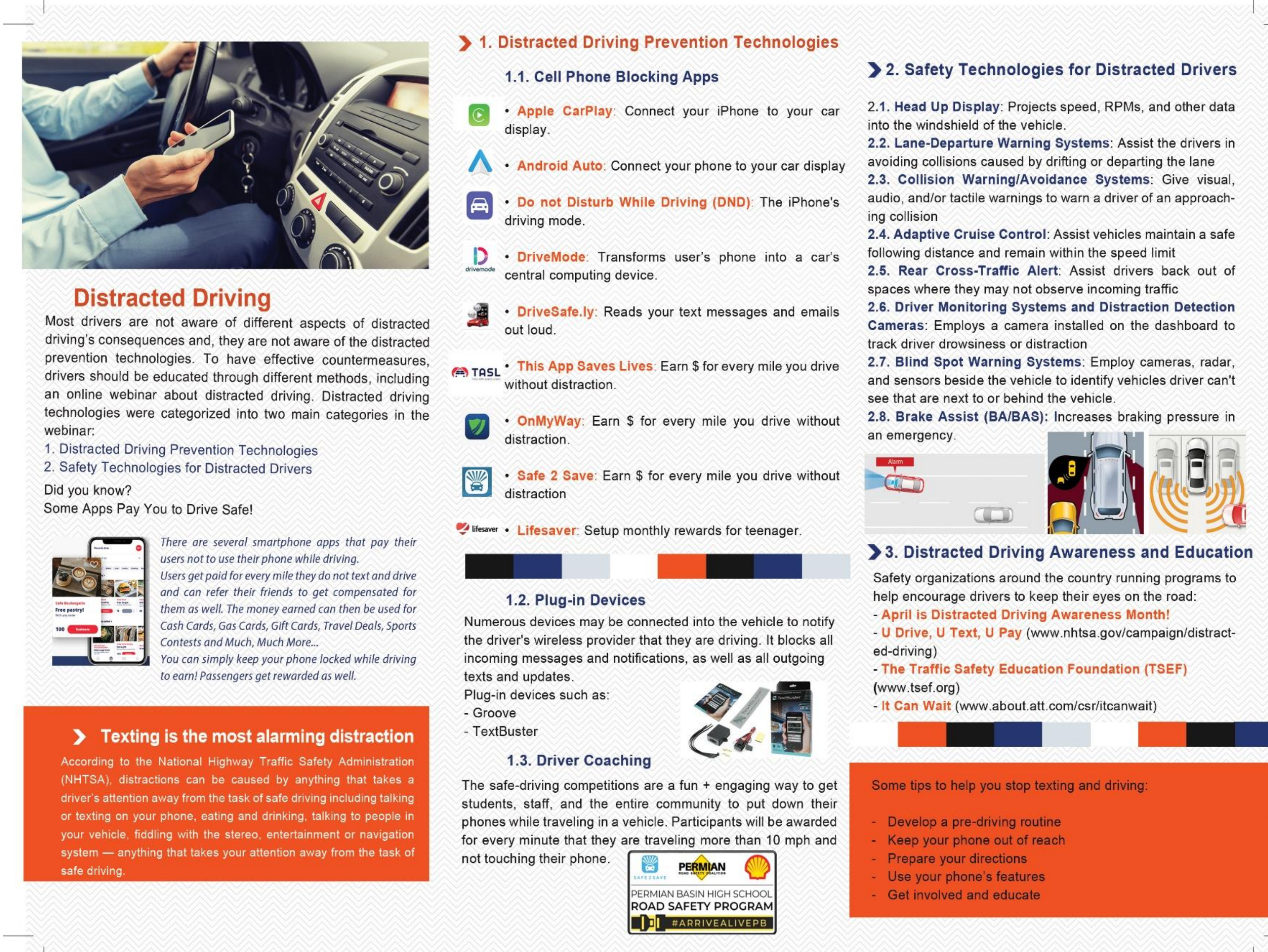

Distracted Driving

Most drivers are not aware of different aspects of distracted driving's consequences and, they are not aware of the distracted prevention technologies. To have effective countermeasures, drivers should be educated through different methods, including an online webinar about distracted driving. Distracted driving technologies were categorized into two main categories in the webinar:

1. Distracted Driving Prevention Technologies
2. Safety Technologies for Distracted Drivers

Did you know?
Some Apps Pay You to Drive Safe!

There are several smartphone apps that pay their users not to use their phone while driving. Users get paid for every mile they do not text and drive and can refer their friends to get compensated for them as well. The money earned can then be used for Cash Cards, Gas Cards, Gift Cards, Travel Deals, Sports Contests and Much, Much More... You can simply keep your phone locked while driving to earn! Passengers get rewarded as well.

Texting is the most alarming distraction

According to the National Highway Traffic Safety Administration (NHTSA), distractions can be caused by anything that takes a driver's attention away from the task of safe driving including talking or texting on your phone, eating and drinking, talking to people in your vehicle, fiddling with the stereo, entertainment or navigation system — anything that takes your attention away from the task of safe driving.

1. Distracted Driving Prevention Technologies

1.1. Cell Phone Blocking Apps

- **Apple CarPlay**: Connect your iPhone to your car display.
- **Android Auto**: Connect your phone to your car display
- **Do not Disturb While Driving (DND)**: The iPhone's driving mode.
- **DriveMode**: Transforms user's phone into a car's central computing device.
- **DriveSafe.ly**: Reads your text messages and emails out loud.
- **This App Saves Lives**: Earn $ for every mile you drive without distraction.
- **OnMyWay**: Earn $ for every mile you drive without distraction.
- **Safe 2 Save**: Earn $ for every mile you drive without distraction
- **Lifesaver**: Setup monthly rewards for teenager.

1.2. Plug-in Devices

Numerous devices may be connected into the vehicle to notify the driver's wireless provider that they are driving. It blocks all incoming messages and notifications, as well as all outgoing texts and updates.
Plug-in devices such as:
- Groove
- TextBuster

1.3. Driver Coaching

The safe-driving competitions are a fun + engaging way to get students, staff, and the entire community to put down their phones while traveling in a vehicle. Participants will be awarded for every minute that they are traveling more than 10 mph and not touching their phone.

PERMIAN BASIN HIGH SCHOOL ROAD SAFETY PROGRAM #ARRIVEALIVEPB

2. Safety Technologies for Distracted Drivers

2.1. Head Up Display: Projects speed, RPMs, and other data into the windshield of the vehicle.
2.2. Lane-Departure Warning Systems: Assist the drivers in avoiding collisions caused by drifting or departing the lane
2.3. Collision Warning/Avoidance Systems: Give visual, audio, and/or tactile warnings to warn a driver of an approaching collision
2.4. Adaptive Cruise Control: Assist vehicles maintain a safe following distance and remain within the speed limit
2.5. Rear Cross-Traffic Alert: Assist drivers back out of spaces where they may not observe incoming traffic
2.6. Driver Monitoring Systems and Distraction Detection Cameras: Employs a camera installed on the dashboard to track driver drowsiness or distraction
2.7. Blind Spot Warning Systems: Employ cameras, radar, and sensors beside the vehicle to identify vehicles driver can't see that are next to or behind the vehicle.
2.8. Brake Assist (BA/BAS): Increases braking pressure in an emergency.

3. Distracted Driving Awareness and Education

Safety organizations around the country running programs to help encourage drivers to keep their eyes on the road:
- **April is Distracted Driving Awareness Month!**
- **U Drive, U Text, U Pay** (www.nhtsa.gov/campaign/distracted-driving)
- **The Traffic Safety Education Foundation (TSEF)** (www.tsef.org)
- **It Can Wait** (www.about.att.com/csr/itcanwait)

Some tips to help you stop texting and driving:

- Develop a pre-driving routine
- Keep your phone out of reach
- Prepare your directions
- Use your phone's features
- Get involved and educate

FIGURE 59 Occupant Protection Fact Sheet

4. OCCUPANT PROTECTION WEBINAR FOR PEOPLE WITH DISABILITIES

The second webinar, which was about occupant protection technologies for people with disabilities, was held on September 16, 2022. **Figure 59** shows the outline of the webinar.

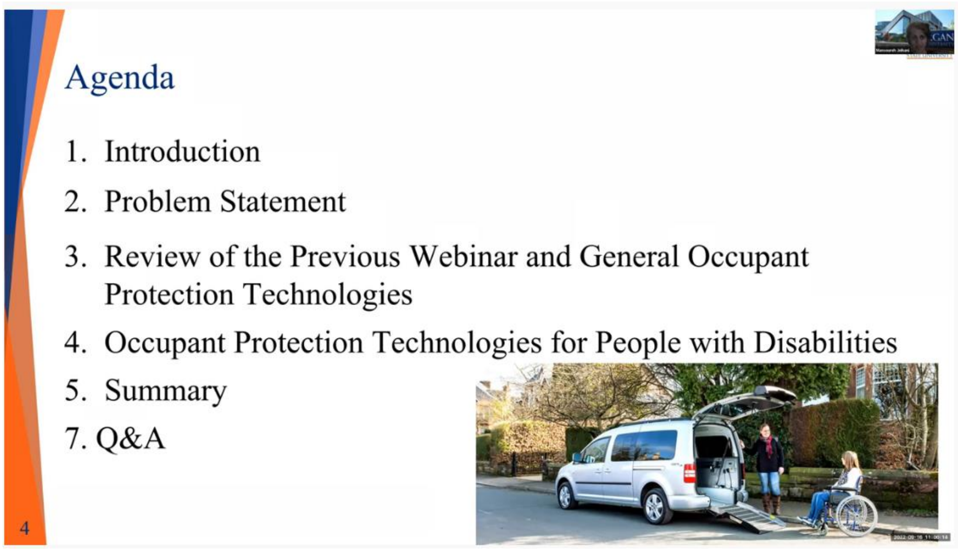

FIGURE 60 The Outline of the First Webinar

The webinar started with an introduction to occupant protection systems, explaining their importance, relevant facts, and associated technologies. The first section of the webinar was a review of all the general occupant protection technologies that were presented in the first webinar.

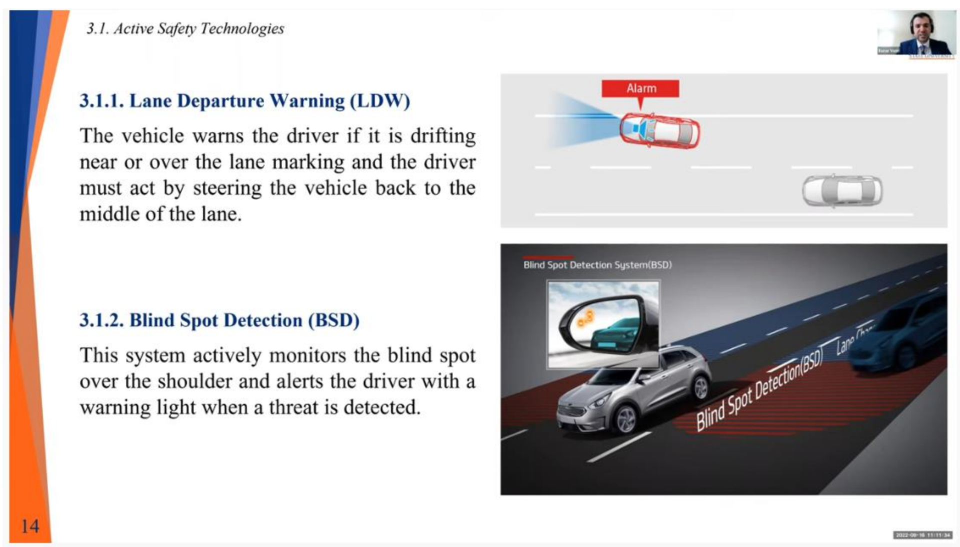

FIGURE 61 The first part of the Webinar

The second part of the webinar was about occupant protection for people with disabilities. First, some facts about the challenges that people with disabilities face in transportation were mentioned.

Then, occupant protection technologies for people with disabilities were categorized into four main sections: 1. Safety Technologies for Visually Impaired Drivers; 2. Safety Technologies for Hearing Impaired Drivers; 3. Safety Technologies for Physically Impaired Drivers; and 4. Smartphone Applications That Help Drivers with Disabilities. In the first category, safety technologies for people with visual impairments, bioptic glasses, AV cars (Waymo one), lane departure warnings, backup cameras, auto-dimming rear-view mirrors, pedestrian and bicycle detection, parking assist, and other technologies were presented to the audience.

FIGURE 62 Technologies for Visual Impaired Drivers

In the second category, safety technologies for people with hearing impairments, Audio-Visual Conversion (AVC), Audio-Tactile Conversion (ATC), The Quiet Taxi, and vehicle modifications such as an alert that lets the drivers know when their signal is still on and an alter that lets the drivers know when emergency sirens are going off nearby were presented.

FIGURE 63 Technologies for Hearing Impaired Drivers

In the third category, safety technologies for people with physical impairments, hand controls, steering, mirrors, seats, different types of handicap-accessible vehicles, wheelchair restraint systems, and the first EV made specifically for wheelchair users (Kenguru) were presented to the audience.

FIGURE 64 Technologies for Physical Impaired Drivers

For each technology, illustrations and videos were presented to help the audience understand how that specific technology works.

In the end, a summary of all the technologies was presented to the audience. Moreover, a section was dedicated to Q&A with the audience. Overall, 44 people joined the webinar. Some of the audience expressed their feelings in learning more in-depth about "Waymo AV cars" and some additional new safety technologies.

The link to the recorded webinar can be found here:

https://www.youtube.com/watch?v=NAukDsCNmpc&list=PL3tN3CUqYVDDIA72q05CVukV3ClLUdDo2&index=5

5. SUMMARY

Between 2017 to 2021, an average of 548 fatalities and 45,524 injuries happened due to crashes in the State of Maryland (*84*). Occupant protection systems are designed to keep the forces acting on passengers low during a crash and limit their effects (*85*). Therefore, using technologies like seatbelts, airbags, etc., can reduce the number and severity of crashes. The purpose of this project was first to comprehensively review all the technologies related to occupant protection and also all the technologies related to occupant protection for people with disabilities using all available websites and related articles. Overall, 26 active safety technologies and 8 passive safety technologies were found regarding general occupant protection technologies. Also, 19 technologies were found related to occupant protection for people with disabilities.

Moreover, to promote a culture of safety, the research team conducted two webinars on occupant protection technologies and occupant protection technologies for people with disabilities. The first webinar was held on April 15, 2022, with the goal of educating Maryland drivers about occupant protection technologies. The second webinar was held on September 16, 2022, and the goal was to educate Maryland drivers about occupant protection technologies for those with disabilities. Overall, more than 60 people participated in these two webinars. Some of the audience expressed their feelings about learning more in-depth about “child safety seats” and other safety technologies. Moreover, some participants mentioned that the webinar introduced them to new technologies such as backseat airbags, belt bags, and turn assist. Moreover, some of the audience expressed their feelings about learning more in-depth about “Waymo AV cars” and some additional new safety technologies.

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