SKAVA
Safe Kids in Automated Vehicles Alliance

White Paper: Emerging Technologies on the Road and Child Safety Implications

April 2024

Introduction

The Safe Kids in Automated Vehicle Alliance (SKAVA) is a partnership of leading children's safety organizations and advocates examining advancing vehicle technologies and their implications for children's safety as passengers, pedestrians, and vulnerable road users. Led by Safe Kids Worldwide, SKAVA began with a focus on child passenger safety and automated vehicles (AVs) in 2017 and has subsequently expanded its scope to include advanced driver assistance systems, electric vehicles (EVs), and micromobility technologies. This white paper describes recent developments in these areas and their potential implications for child safety on the road.

Although fully automated vehicles are not yet publicly available for purchase, vehicles are on the road today that leverage varying degrees of this technology. On the road to driverless cars, partially automated vehicles have also introduced valuable safety features, such as lane keeping assist systems, adaptive cruise control, blind spot monitoring and self-parking. The latter technologies are readily available in newer vehicle models and are helping to keep roads safer, both for passengers and other road users. The increasing popularity of micromobility solutions and the ongoing shift towards EVs also present new traffic safety challenges and opportunities. We support responsible adoption of several technologies outlined below and anticipate that a shift in education and awareness efforts will be needed to ensure the safety of children in the future.

Car Seat Advancements

Proper use of child safety seats ("car seats") and booster seats has proven to be an effective intervention against motor vehicle crash injury for child vehicle occupants. Research shows that proper car seat use lowers the risk of fatal injuries by 71 percent for children in the first year of life and by 54 percent for children ages 1 to 4.[1] Their use has also been shown to reduce the severity of injuries and need for hospitalization. Booster seats, combined with vehicle lap and shoulder belts, reduce the risk of injury to children ages 4 to 8 years by an additional 45 percent when compared to seat belts alone.[2]

As we learn more about how children continue to be hurt in crashes, and identify effective interventions to reduce common injuries, car seats and booster seats continue to evolve. Designers and manufacturers voluntarily improve the safety devices for better crash protection and easier correct use, on a continuing basis. Stringent federal regulations requiring crash performance standards also continue to evolve, since their inception in 1971, requiring enhanced crash performance and updating the included test configurations and measurements to more accurately reflect vehicle environments and real-world crash trends. In fact, three new sets of requirements to improve child occupant protection will be implemented from 2024 through 2026.

As vehicle designs adopt more Advanced Driver Assistance Systems (ADAS) and progress toward Autonomous Driving Systems (ADS), SKAVA is confident that crashes will become less frequent and

collectively less severe, reducing both fatal and nonfatal injury to children. We also know, however, that crashes will continue to occur for the foreseeable future, so effective child restraint systems will remain crucial. These child safety devices must remain compatible with new vehicle environments, optimized for evolving crash trends, and convenient for correct use in current and future transportation systems.

With automated driving, we are likely to see changes to vehicles that require child restraint advances. High level changes may include:

- Direction of travel differences as bi-directional vehicles are introduced.
- Evolving uses of existing vehicle interiors and introduction of novel vehicle interior designs, including carriage-style seating and flexible seat arrangements.
- Increased use of rideshare transportation models, requiring frequent car seat attachment in a variety of vehicles.
- Vehicle ingress/egress challenges for families and rider groups in situations with limited or lacking loading zone infrastructure.
- Need for additional pre-travel time for families/caregivers to assess vehicle compatibility with a child safety seat, install the device and harness child passenger(s).
- Potential shifts in the distribution of initial crash impact directions, which could create a need for optimizing car seat designs for protection in certain crash types.

Heatstroke Prevention Advancements

Pediatric vehicular heatstroke is a leading cause of nontraffic child fatalities in the U.S. According to NHTSA, more than 950 children have died since 1998 because they were left or became trapped in a hot car.[3] We have lost an average of 37 children each year in that timespan. In 2023 alone, 29 kids were killed in hot cars when they were either unknowingly left in the vehicle or got into the car without supervision and became trapped.[4]

These deaths are especially tragic because they are preventable. Children can die when their body temperature reaches 107 degrees. Each year, NHTSA conducts an extensive education campaign called *Look Before you Lock*. It involves paid and earned media and warns parents and caregivers to check their vehicles before leaving, along with other prevention strategies. While educational campaigns are important and must be conducted to remind the public about the dangers of heatstroke, new technologies are emerging that could have a significant impact on reducing hot car deaths.

For the past decade, studies have continued to evaluate the effectiveness of rear seat reminder technologies for children knowingly left in vehicles, unknowingly left in vehicles, and for children who gain access to unattended vehicles. The child alert technologies are assessed in how well they would perform under the types of circumstances that most often result in a child fatality.

The Infrastructure Investment and Jobs Act (IIJA, Pub. L. 117-58) mandates that new passenger vehicles be equipped with a system to alert the driver to check the rear seats. While the included deadline for finalization and implementation has passed, the National Highway Traffic Safety Administration has announced a rulemaking in compliance with this rule which, as of this writing, is currently pending action.[5]

Child alert technologies take different forms, from door logic systems to vulnerable occupant detection, and can be included as ADAS or ADS features. SKAVA supports the development of effective detection and warning solutions that could help prevent pediatric heat stroke deaths.

Several OEMs are developing systems which show tremendous potential to detect and prevent children from being accidentally left behind. For example, Hyundai's Advanced Rear Occupant Alert uses in-vehicle sensors to detect children and pets in the vehicle. According to Hyundai:

> *As the engine is turned off, a visual warning in the instrument cluster reminds you to check the rear seats before exiting. Additionally, overhead sensors monitor the backseat area to minimize the risk of a child or pet accidentally left inside after the vehicle is parked and locked. If sensors detect movement, the horn will honk, lights will flash and your smartphone will receive an alert through Bluelink.*[6]

Camera-based safety systems, known as Driver Monitoring Systems (DMS) and increasingly known as Occupant Monitoring Systems (OMS), use camera-based sensors to monitor the driver and vehicle occupants, respectively. These systems are increasing in use as Driver Assist systems providing L2, L2 plus, and L3 hands free driving are increasing in use. Systems like General Motor's Supercruise and Ford's Blue Cruise provide the convenience of hands-free driving in certain situations. These systems rely on monitoring the driver to ensure they are ready for takeover in certain situations.

The same cameras used for driver engagement can be used to detect the presence of a child in the vehicle. Most cameras face the driver and passenger, therefore, limitations include restricting occupant detection in car seats to those forward facing. However, the installation of a second camera could help detection in rear-facing car seats.

Occupant detection and monitoring technology is gaining momentum in the industry. European regulations require DMS for detection of distraction and drowsiness beginning in July 2024. U.S. regulators are considering camera-based detection of distracted driving, drowsy driving, and drunk driving in a January 2024 Advanced Notice of Proposed Rulemaking.

As these regulatory momentum increases, SKAVA will continue engagement on how DMS/OMS systems could assist in detecting unsupervised children in vehicles. SKAVA looks forward to working with NHTSA, OEMs, and other safety organizations to promote technological solutions to prevent pediatric heatstroke.

Advanced Driver Assistance Systems

Advanced Driver Assistance Systems (ADAS) are vehicle technologies that help drivers perform the safe operation of a vehicle. By using a human-machine interface, ADAS increases car and road safety by incorporating automated technologies, such as sensors and cameras, to detect nearby obstacles and prevent driver errors. SKAVA supports several vehicle features which are shown to reduce death and injuries on and around the roads, including Automatic Emergency Braking, Lane Departure Warnings, and Lane Keep Assistance.

Automatic Emergency Braking
Automatic Emergency Braking (AEB) systems brake automatically if a collision is imminent, and the driver is not taking any action (or is not doing so fast enough). AEB is able to detect a potential collision and activate the braking system to decelerate the vehicle with the purpose of avoiding a collision, or at least mitigating its impact. Pedestrian AEB (PAEB) adds the feature of pedestrian detection and can help stop the vehicle when pedestrian collisions are imminent.

Children are especially vulnerable pedestrians and can benefit from robust AEB and PAEB systems. In June 2023, NHTSA issued a Notice of Proposed Rulemaking (NPRM) to require AEB and PAEB on passenger cars. NHTSA projects that an AEB rule would save at least 360 lives each year and prevent 24,000 injuries.[7]

Lane Departure Warnings and Lane Keep Assistance
Lane Departure and Lane Keeping Assistance systems use cameras to track lane position and alert the driver if the vehicle inadvertently strays across lane markings if the turn signal is not used. Warnings can include audio, visual, or haptic alerts. Lane Keep Assist automatically adjusts the steering to correct lane departure. This is done through minor steering wheel adjustments or light braking.

Lane Departure Technology has been shown to reduce rates of single vehicle crashes, sideswipe, and head on crashes.[8] These technologies are an important step in the advancement of driver assistance technologies. Forward camera sensors can help keep the vehicle centered in the lane and improve safety. Today these technologies help enable autonomous features like hands-free driving which are the first step toward autonomy.

Vehicle Size and Weight

The U.S. vehicle fleet has steadily grown over the years and in 2021, sports utility vehicles (SUVs), vans, and pickups accounted for 63 percent of new vehicles sold in the U.S.[9] Over the past 20 years, the size and weight of trucks, SUVs and passenger cars has steadily increased.[10] The increase in size reflects consumer demands for bigger cars and SUVs, along with heavier designs required for electric vehicles. According to the Insurance Institute for Highway Safety (IIHS), “A bigger, heavier vehicle provides better crash protection than a smaller, lighter one, assuming no other differences between them.”[11]

While this may be true for car-on-car or single vehicle crashes, SKAVA has concerns about the safety impacts on pedestrians and especially children who may be especially vulnerable to pedestrian crashes.

Another report from the IIHS found SUVs with hood heights greater than 40 inches are about 40 percent more likely to cause pedestrian deaths versus shorter vehicles with sloped hoods.[12]

In addition to the increase in SUV and pickup trucks, the U.S. is in the early phases of transitioning to electric vehicles (EVs). The Biden Administration set a goal of having 50 percent of all new car sales be electric by 2030.[13] While goals may be adjusted, 1.4 million electric vehicles were sold in the U.S. in 2023, a 50 percent increase in one year.[14] EVs are promoted for their ability to reduce carbon emissions. However, batteries used to power EVs are heavier than traditional Internal Combustion Engine vehicles. The additional weight can be deadly when colliding with pedestrians or other vehicles.[15]

Additional weight in vehicles can cause more damages in vehicular crashes, especially those involving pedestrians. As SKAVA has included pedestrian safety as a focus area because of the particular impact on children as pedestrians, the increase in vehicle weight is a concern. Therefore, it is critical that as new EVs are introduced, they come equipped with standard, robust safety features including the latest ADAS systems aimed at protecting pedestrians. EVs have the potential to reduce global emissions and help the environment while creating new challenges due to weight.

SKAVA looks forward to working with OEMs as they continue to roll out new electric vehicles. The safety of our children and pedestrians must be taken into consideration.

Distraction

Distracted driving is now clearly a leading killer of road users. A study released in 2023 looked at the cost of motor vehicle crashes in the U.S. and announced some new statistics that, while not surprising, dramatically increased the estimates of distracted driving deaths and injuries. According to the report, in 2019 distracted driving killed 10,546 people, caused 1.3 million injuries, and cost $98.2 billion.[16]

For years, distracted driving has been vastly underreported as crashes caused by distraction may be hard to identify for various reasons. In January 2024, NHTSA issued an Advanced Notice of Proposed Rulemaking (ANPRM) for Advanced Impaired Driving Prevention Technology. As part of the ANPRM, NHTSA reports that 12,405 people were killed by distracted driving in 2021, costing $158 billion.[17]

SKAVA commends NHTSA for broadening the definition of impairment to include distraction and drowsiness. As part of the ANPRM, NHTSA is now seeking technologies that can identify drivers impaired by alcohol, distraction, and drowsiness.

In 2023, the European New Car Assessment Program (EuroNCAP) began awarding points to vehicles that use DMS systems to detect driver distraction. In July 2024, European regulations will require DMS for all new vehicles to detect distracted driving. Future versions of EuroNCAP's safety roadmap will require DMS to detect impairment from alcohol.

SKAVA believes that alcohol impaired driving, distracted driving, and drowsy driving represent some of the leading causes of death and injury on the roadways. Technologies that can detect and warn drivers and potentially in the future take over some or all of the driving task could be game changers in making the roads safer for cars and pedestrians. This of course includes children.

Micromobility Devices and Platforms

Micromobility (MM) users face many hazards common to all vulnerable road users, especially crashes, but some of their unique characteristics also create new ones including battery fires and storage/parking issues. Unsurprisingly, MM crashes involving a motor vehicle ("MM-MVC crashes") often involve the worst injuries and outcomes for the MM user. Parking and loading zones are of particular interest here because less predictable movements in these spaces by either motor vehicles or MM users can often be the cause of an incident. Because MM devices are often used as a "first-mile/last-mile" supplement to transit services, areas surrounding rail and bus stops may also be at higher risk of an MM-MVC crash.

We also see crashes and injuries resulting from incidents involving an MM user and another vulnerable road user such as a pedestrian, bicyclist, or other MM user. These incidents can occur in a general traffic lane of the roadway, in a crosswalk or sidewalk, or in a bike lane. While injuries might or might not be less severe in this category, they tend to be more widely distributed across participants in an incident since both parties to the crash lack the increased protection and weight associated with a motor vehicle.

Crashes and injuries also stem from aspects of the built roadway environment incompatible with MM capacities, possibly an infrastructure feature or damage. For example, inlaid streetcar tracks can easily catch the wheels of an e-bike or e-scooter leading to an ejection, potentially in a traffic lane. An unrepaired pothole could easily do the same.

In September 2023, the U.S. Consumer Product Safety Commission released an investigation into injury trends associated with micromobility products from 2017 to 2022. Their analysis reported an estimated 360,800 Emergency Department visits and 233 deaths associated with MM products over this 5-year span. Both ED visits and deaths increased in a statistically significant and linear trend, with fatalities in particular rising from 5 deaths in 2017 to 76 in 2022.[18]

CPSC's 2023 report also looked into ED visits and deaths by type of MM device, in particular e-scooters, hoverboards, and e-bikes. It also included the results of 314 follow-up investigations across the categories, allowing for the identification of leading hazards patterns associated with each.

E-scooters represented 139,000 ED visits and 111 fatalities over this period, also an increasing linear trend. Among E-scooter related ED visits, just over 29,000 (17 percent) were associated with a dockless or rental scooter. Follow up investigations found that fires (50.6 percent) and brake issues (21.3 percent) were the leading hazard patterns for e-scooters.

The CPSC also undertook a special study on e-scooters in 2022. In this study, commission staff followed up on 309 incidents and their surrounding circumstances. Of particular note, 37 percent of visits in this study were associated with rental scooters, compared to only 17 percent in the wider dataset discussed above. This may point to an underestimate in the overall set resulting from EDs being unable to ascertain this element at the time of treatment.

Hoverboards represented 138,400 ED visits and 18 fatalities, with ED visits for hoverboards showing a downward trend. Follow up investigations found that fires (83.7 percent) and other electrical issues (12 percent) were the leading hazard patterns for e-scooters. 72 percent of deaths associated with

hoverboards were linked to just 6 fire incidents. E-bikes represented 53,200 ED visits and 104 fatalities, also a trend of linear increase. E-Bikes represented about 15 percent of ED visits in the overall set.

Micromobility and Equity

We see the emergence of micromobility as a profound opportunity to improve access to transportation options in communities that have been historically marginalized and underserved, especially in the context of first-mile and last-mile connection to transit or other legacy transportation modes. However, questions remain about equity and micromobility. How are rental/dockless providers engaging communities in which they operate around questions of distribution? If dockless devices such as scooters and bikes are not equitably distributed after charging/maintenance, this can further contribute to access disparities. In the CPSC's recent study discussed above, staff found that non-Hispanic Black consumers made up 29 percent of micromobility injuries overall, and 32 percent for e-scooters and e-bikes – a figure significantly out of proportion with their 13 percent population share nationwide.

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