Response to Request for Comments on DOT Automated Vehicles Comprehensive Plan

The Human Factors and Ergonomics Society (HFES) and the American Psychological Association (APA) would like to take the opportunity to comment on the U.S. Department of Transportation Automated Vehicles Comprehensive Plan as requested in the Federal Register (DOT–OST–2021–0005). The plan identifies 3 goals: (1) promoting collaboration and transparency, (2) modernizing the regulatory environment, and (3) preparing the transportation system, which includes foundational research and development supporting transportation safety, efficiency, and accessibility. These goals are consistent with those of HFES whose focus is on systems that work safely and effectively for humans.

HFES has issued a set of specific recommendations on the development of safe autonomous and semi-autonomous vehicles (appended below) that fall into 4 main areas:

1. Automated vehicles require careful testing before deployment on public roads.
2. Automated vehicles should support the needs of human drivers and other users.
3. Automated vehicles should be safe and understandable.
4. Automated vehicles should be accompanied by detailed training for drivers.

Keeping those 4 themes in mind, selected comments on the DOT Comprehensive Plan follow.

Page 3, Goal 1 Prioritize Safety. The first principle of the DOT Comprehensive Plan to automated driving systems (ADS) is to Prioritize Safety. We highly endorse safety as the number one priority for any introduction of automated vehicles onto the nation's roadways. It is critical both for the prevention of deaths and injuries to American drivers, passengers and pedestrians, and to the development of public confidence and willingness to use automated vehicles in future.

Automated driving technologies significantly affect human performance, potentially negating potential benefits, and should be designed and tested to address human performance issues before being introduced onto public roads. The expectation that automated driving systems will necessarily enhance safety fails to take into account the significant effect these systems have on human performance. The human performance issues that automated driving technologies could introduce include loss of driver engagement and low situation awareness, poor understanding of and overreliance on automated systems, and loss of manual skills needed for performance and decision-making. Many challenges for human drivers and operators of highly automated vehicles have been found.

Replacing a driver with an automated driving system does not eliminate the human from the system. Rather, it replaces a human driver with human-designed automation, subject to its own set of human-related safety challenges. Automated driving systems will have new implications for operators inside the vehicle, other drivers and operators, and other road users, like pedestrians, cyclists and people with disabilities. It is crucial that the DOT and the companies designing these systems proactively engage with experts who understand the tradeoffs of partnering humans with complex automation.

Page 3, Goal 3 Ensure Privacy and Data Security – We strongly support the importance of privacy and data security. Emphasis is often placed on securing data relevant to the vehicle and the driver, but it should also be recognized that in today’s world, misinformation can pose a threat of equal concern that should be incorporated into these efforts.

Page 4, Goal 7 Modernize Regulations - Currently, the DOT Comprehensive Plan does not sufficiently address the actions needed to ensure the safety of ADS before regulations are changed and they are introduced onto
the nation's roadways. Any actions to reduce current safety standards and regulations, or provide exemptions for ADS, prior to their demonstration of safety and reliability of operation in real world driving conditions, will inadvertently compromise safety in ways that may not be obvious to consumers. Specifically, in keeping with Goal 1 – Safety – A strong emphasis should be placed on careful testing of ADS technologies prior to reducing current safety standards.

Automated vehicles are not currently fully reliable or capable of recognizing or avoiding all accident conditions. Although it is easy to point to accidents in which human drivers play a significant role, this view neglects the strong safety component that experienced and knowledgeable drivers bring to the avoidance of accidents on a daily basis. For example, 2016 data shows that people average 495,000 miles between accidents and over 95 million miles between fatal accidents. No automated vehicle comes even close to this level of performance, and it will be many years before they do. (The best is currently Google/Waymo at 13,220 miles per human intervention as reported to the State of California in 2019). Given that highly automated vehicles that are capable of matching/out-performing humans are so far away, it is imprudent to remove existing safety standards without clearly establishing new laws that are needed to guide their safe introduction.

Page 4, Goal 10 Improve Transportation System-Level Effects – Although the focus of HFES and APA is on the human element, this is done to enhance overall system performance, a focus consistent with this principle.

Page 9, Voluntary Safety Self-Assessment – To a large degree, these are written at such a high level and so generally, that it is difficult to judge the rigor of these assessments. A notable exception is some of the information provided by Waymo, and there could be others. We urge DOT to modify the template (https://www.nhtsa.gov/automated-driving-systems/voluntary-safety-self-assessment) for these assessments to make it apparent that specific data is expected. We also strongly recommend that safety assessments be required prior to approval for roadway use.

Currently the DOT Comprehensive Plan does not sufficiently address the actions needed to ensure the safety of ADS before they are introduced. Any actions to reduce current safety standards and regulations, or provide exemptions for ADS, prior to their demonstration of safety and reliability of operation in real world driving conditions, will inadvertently compromise safety in ways that may not be obvious to consumers.

Failing to sufficiently attend to the potential for automation to degrade human performance, and to consider the needs of drivers and other roadway users to develop accurate levels of trust in these devices, can significantly impact safety and undermine public acceptance of the technology. As the recent crashes of the Boeing 737-Max8 demonstrate, commercial pressures may induce companies to take short cuts in the design and testing of automated systems that result in inadequate attention to these issues. This indicates the need for strong leadership by the DOT to ensure that safety is adequately addressed in the development and introduction of ADS.

Page 9, Automated Vehicle Transparency and Engagement for Safe Testing (AV TEST) Initiative (NHTSA) – The goal of this effort is to be transparent in informing the public, among others, about AV testing. However, the web site is not listed.

Page 9 and 10, Voluntary Technical Standards - The Comprehensive Plan lists a number of voluntary technical standards that could pertain to automated vehicles. Although all of these standards are developed by recognized standards development organization for whom participation is open to the public, it is often the case in the U.S., it is often the case that participation by members of the academic community is low, in part because their employers do not provide funding for their time and because participating in standards activities does not lead to tenure. Participation by members of the academic community on such standards
boards is important to ensure that relevant research knowledge is brought to bear in informing standards and that they reflect relevant scientific consensus. DOT can redress this problem by direct funding of such efforts and by allocating funding in DOT research projects. Keep in mind that to be effective, participation on a committee needs to span at least 3-5 years.

In addition, conspicuous in its absence is SAE J2944 (Operational Definitions of Driving Performance Measures and Statistics.), which we strongly recommend be included in ADS research and development efforts.

**Page 15, Update Infrastructure standard to reflect ADS technologies** – The focus of this section is on the Manual of Uniform Traffic Control Devices (MUTCD). However, there are many other fundamental publications that could be affected by the introduction of vehicle automation such as the Highway Capacity Manual and the AASHTO Green book. These should also be addressed.

**Page 19, Passenger Vehicle Conditional Driving Automation (SAE Level 3)** - The emphasis of research on this topic should focus on testing. Models of human performance are needed that make quantifiable predictions about human performance as a function of the automation human-machine interface, that have been validated by testing. The study of operation of these systems needs to be more science based and foundational.

The issue of providing a safe hand-off between ADS and human drivers has been extensively researched in the human factors literature. This research base should be leveraged for the establishment of safe, effective procedures and timelines for vehicle control handover. (e.g. see Zhang, B., de Winter, J., Varotto, S., Happee, R., & Martens, M. (2019). Determinants of take-over time from automated driving: A meta-analysis of 129 studies. Transportation Research Part F: Traffic Psychology and Behaviour, 64(May), 285–307. [https://doi.org/10.1016/j.trf.2019.04.020](https://doi.org/10.1016/j.trf.2019.04.020)

**Additional Comments:** Attention to requirements for Training and education of human drivers who much interact with ADS is currently missing and has been shown to be important. (e.g. see ANSI/ASSE Z15.1-2017 Safe Practice for Motor Vehicle Operations). Automobile manufacturers should provide sufficient training on the capabilities, limitations, and behaviors of its automated and semiautomated systems (including the range of operational conditions it can handle) so that drivers obtain an accurate mental model required for effective oversight and interaction with them. New training should be provided on any automation updates that are made over the course of the system’s lifetime so that the automation’s behavior remains predictable to the driver. Automated vehicle test drivers operating on public roadways should receive extensive training on the capabilities of the automation, as well as instructions for remaining vigilant and providing rapid intervention. They should be provided with displays and controls to support this role with and monitoring systems to ensure they remain vigilant and able to intervene rapidly.

We also strongly emphasize the importance of trust in AVs as essential for successful and safe development in the US. Trustworthiness in automated systems is a substantial component of human-automation interaction and should be considered during ADS deployment. A deeper understanding of the process by which humans establish trust in automated technologies is needed to better determine the variables and contexts that are the greatest contributors at the group and individual levels. Both contributing to and complementing human factors research, behavioral and psychological science research is necessary to inform the design of ADS by computer scientists and engineers that are more trustworthy to human operators. HFES and APA are both eager to work with the Department of Transportation as you continue planning for autonomous vehicles in the U.S. and encourage additional human-automation interaction research towards the safe development of ADS.
Finally, it is important that development and testing of ADS concepts that involve interaction with human drivers or users be conducted by qualified human factors professionals (www.bcpe.org) who can take into account the science base on human error and human performance, and established human research testing protocols.

Thank you for the opportunity to review the DOT Automated Vehicles Comprehensive Plan. HFES and APA strongly support the safe development of AVs, using an approach that incorporates the extensive human factors research base on human-automation interaction and the involvement of qualified human factors research professionals. This is needed to ensure that appropriate attention to human error and human performance in conjunction with ADS be taken into account. The ultimate success of ADS and the establishment of trust by the driving public is highly dependent on this collaborative development effort.

About the Human Factors and Ergonomics Society (HFES)

With over 4,600 members, HFES is the world’s largest nonprofit association for human factors and ergonomics professionals. HFES members include psychologists, engineers and other professionals who have a common interest in working to develop safe, effective, and practical human use of technology, particularly in challenging settings.

About the American Psychological Association (APA)

The American Psychological Association is the leading scientific and professional organization representing psychology in the United States, with more than 122,000 researchers, educators, consultants and students as its members. APA’s mission is to promote the advancement, communication, and application of psychological science and knowledge to benefit society and improve lives.

HFES Recommendations for Advanced Driving Systems

To more successfully reach the goals of safe introduction of ADS, HFES strongly recommends that DOT develop and implement requirements for testing, support for integration with human drivers and other users, the development of new standards for ADS safety and understandability, and new standards for driver training.

I. Automated vehicles require careful testing before deployment on public roads.

1. The design, development, and testing of automated and semiautomated vehicles requires the careful assessment of human performance when operating in conjunction with such systems. Autonomous and semiautonomous driving systems must be required to pass testing that demonstrates that the combined performance of the driver and the vehicle technology is as safe as or safer than human drivers alone in a wide range of driving and weather conditions. [SAE Level 2/3/4/5]

2. Highly automated systems should perform at a level equivalent to that required of human drivers. In addition, such systems must be required to perform basic tasks that are currently performed by human drivers (including detection and identification of safety signage, and detection and avoidance of obstacles, vehicles, cyclists, and pedestrians). For fully autonomous vehicles [SAE Level 5], testing must include, at a minimum, an ability to detect and safely avoid obstacles, debris, pedestrians, bicyclists, vehicles, and animals, and manage other roadway conditions and hazards. It must include the ability to accurately detect and recognize roadway signage and signaling, even when that signage has been degraded by sun, weather, dirt, tree branches, and other factors common in the driving environment. [SAE Level 4/5]
II. Automated vehicles should support the needs of human drivers and other users.

3. The design of semiautomated vehicles must avoid known human performance issues\(^2\) and provide effective mechanisms for human oversight and intervention. Semiautonomous vehicle systems must be required to demonstrate equivalent or improved safety, across both situations in which it is reliable and those in which it is not (i.e., safety must be established in automation failure conditions that involve resumption of control or override by human drivers). In cases in which the automation fails, or in situations that it cannot handle, safe transition to human control within the time available to allow accident avoidance is required, taking into account human decision-making and maneuvering time as well as overcoming human vigilance deficits as affected by automation reliability, robustness, and breadth of implementation across vehicle systems. [SAE Level 2/3/4]

4. The ability of the automation to function reliably in the current and upcoming conditions should be clearly displayed to the driver. Driver interfaces should provide accurate situation awareness of the state of the vehicle and the external driving environment as well as automation transparency, to include the automation's current state, settings, and mode; highly salient warnings of automated mode transitions, including transitions to manual mode; and what the automation is aware of, its interpretation of data received, and projected plans or intentions of the automation. [SAE Level 2/3/4]

5. Remote-control interfaces for operating road vehicles must include operator interfaces that provide situation awareness of vehicle trajectories, systems, and states; automation; automobile, cyclist, and pedestrian traffic; and environment and road conditions equivalent to that of an in-vehicle driver, as well as the ability to avoid collisions. [SAE Level 1/2/3/4/5]

6. Fully autonomous vehicles should accommodate people with disabilities. [SAE Level 4/5]

III. Automated vehicles should be safe and understandable.

7. Automation reliability standards and requirements for the conditions that automated vehicle systems should be able to handle must be established for each SAE level to support testing, training, and implementation approval. [SAE Level 2/3/4/5]

8. Highly automated systems should include provisions for safe fallback states when the automation fails for any reason. The safety of these fallback states should consider the consequence of multiple vehicles seeking the same state at the same time. [SAE Level 4/5]

9. Automated systems should include features that allow it to communicate intended actions to cyclists, pedestrians, law enforcement, and other road users [SAE Level 4/5].

10. Automation design should make the underlying algorithms and their behavior interpretable so that its capabilities and limits are clear to designers and policy makers. [SAE Level 2/3/4/5]

IV. Automated vehicles should be accompanied by detailed training for drivers.

11. Automobile manufacturers should provide sufficient training on the capabilities, limitations, and behaviors of its automated and semiautomated systems (including the range of operational conditions it can handle) so that drivers obtain an accurate mental model required for effective oversight and interaction with them. New training should be provided on any automation updates that are made over the course of the system’s lifetime so that the automation’s behavior remains predictable to the driver. [SAE Level 2/3/4]

12. Automated vehicle test drivers operating on public roadways should receive extensive training on the capabilities of the automation, as well as instructions for remaining vigilant and providing rapid intervention. They should be provided with displays and controls to support this role with and monitoring systems to ensure they remain vigilant and able to intervene rapidly. [SAE Level 2/3/4/5]
References