HUMAN FACTORS

Turner-Fairbank
Highway Research Center

Safety R&D Program
SUMMER 2024 - WINTER 2025 | VOLUME 19

FAST LANE

Exploring Human Behavior

Hot Off the Press

Chao, S. F., S. Roldan, and M. Arnold. 2024. *Effects of Signing and Configuration of Partially Automated Truck Platooning on Light-Vehicle Driver Behavior*. Publication No. FHWA-HRT-24-071. Washington, DC: Federal Highway Administration. https://highways.dot.gov/research/publications/safety/FHWA-HRT-24-071, last accessed June 5, 2024.

Chao, S. F., S. Roland, M., Jannat, and M. Arnold. *Human Factors Issues Related to Truck Platooning Operations*. Report No. FHWA-HRT-24-065. Washington DC: Federal Highway Administration. https://highways.dot.gov/research/publications/safety/FHWA-HRT-24-065, last accessed June 12, 2024.

Sanchez, R. R., S. Weaver., and S. F. Chao. 2024. *Response to Emergency Vehicles When Driving in a Mixed Vehicle Fleet*. Report No. FHWA-HRT-24-063. Washington DC: Federal Highway Administration. https://highways.dot.gov/research/publications/safety/FHWA-HRT-24-063, last accessed June 5, 2024.

Sanchez, R. R., S. Weaver, S. F. Chao, and M. Arnold. 2024. *Effects of Work Zone Infrastructure on Transitioning from Automated to Manual Driving for Work Zones with Lane Reductions*. Report No. FHWA-HRT-24-117. Washington DC: Federal Highway Administration. https://highways.dot.gov/research/publications/safety/FHWA-HRT-24-117.dot.gov/research/publications/safety/FHWA-HRT-24-117, last accessed June 5, 2024.

Meet the Team

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Leidos, Human Factors onsite support

**Syntek Technologies,** Highway Driving Simulator onsite support.

TRAVEL LANE

Current Research:

■ **Development of a Virtual Reality (VR) Bicycle Simulator,** led by Jesse Eisert. The research team completed the procurement of hardware and started the software integration process. The objective of this study is to develop and design a high-fidelity VR-based bicycle simulator with open-sourced and upgradable capabilities and full experimental control.

■ **Investigating Key Automated Vehicle (AV) Human Factors Safety Issues Related to Transportation System Management and Operations (TSMO),** led by Michelle Arnold.

» **Merging Behavior When Driving in a Mixed Vehicle Fleet.** The research team completed pilot testing and started data collection. This simulator study aims to help transportation agencies assess the effect of mixed fleets on traffic safety and congestion at on-ramp merge points.

■ **Investigating Key Automated Vehicle (AV) Human Factors Safety Issues Related to Infrastructure,** led by Jesse Eisert.

» **Lane-Change Response to Infrastructure Warning About Lane Closure in a Mixed Vehicle Fleet.** The research team completed pilot testing and started data collection. This simulator study aims to help transportation agencies assess the effect of mixed fleets and connected infrastructure on traffic safety at lane closures.

■ **Traffic Control Device (TCD) Consortium Pooled Fund Study (PFS). Transportation Pooled Fund (TPF)-5(447),** led by Laura Mero.

» **Pedestrian Signing at Uncontrolled Crossings.** The research team completed data collection and is in the process of analyzing the data. The goal of the study is to use human factors experiments to test various pedestrian signing options at uncontrolled crossings to determine signs with high comprehension and that lead to driver yielding.

» **Comprehension and Legibility of Selected Symbol Signs, Phase V.** The research team developed draft alternatives for the sign categories (approximately 20) that will be included in this project. The team is now finalizing the work plan. The objective of this research is to evaluate the possibility of creating a symbol where one does not exist, legibility, and comprehension for new and existing symbols and text-based signs and related plaques, as appropriate, to determine the sign that is best understood and most effective at conveying the intended meaning.

■ **Ensuring Cooperative Driving Automation (CDA) and Vulnerable Road Users' Safety Through Infrastructure: Phase 2,** led by Jesse Eisert. The research team began data collection in the Turner-Fairbank Highway Research Center VR Laboratory. This project examines infrastructure-based solutions for vulnerable road user interactions with CDA-equipped vehicles using VR.

TRAVEL LANE *(continued)*

■ **Exploring Potential Contributors to Racial and Socioeconomic Disparities in Pedestrian and Bicyclist Morbidity and Mortality,** led by Jesse Eisert. The research team successfully convened multiple subject matter expert panels to provide input, recommendations, and feedback throughout this project. The first draft of the literature review has been completed, and feedback has been provided. Additionally, the case studies that will be used for this project have also been selected and are being further explored and developed. A final draft of this project is anticipated Summer 2024.

■ **Evaluation of Aesthetically Treated Crosswalks Phase II,** led by Laura Mero. The research team is collecting data this summer. The objectives of the project are to determine if crosswalks with surface treatments affect road user (drivers, pedestrians, and pedestrians with low vision) behavior as compared to standard crosswalk markings and what conditions and/or aspects of the crosswalks with surface treatments impact road user behavior; this project will take place in the field. The project is in the early planning stages. This is a follow-on to *Evaluation of Aesthetically Treated Crosswalks*, which shared the same objectives and took place in closed course environments.
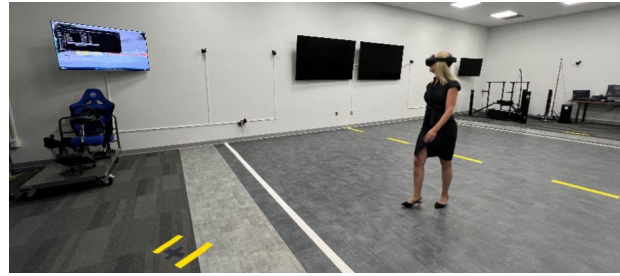
Source: FHWA.

Figure 1. Photo. Participant during Cooperative Driving Automation Vulnerable Road User Phase 2 data collection.

■ **Investigating Nighttime Pedestrian Safety and Conspicuity Using Bollard Lighting,** led by Michelle Arnold, was initiated in September 2023. This closed-course study examines the feasibility of a bollard-based lighting system to provide enhanced visibility for pedestrians in crosswalks as a viable safety strategy for nighttime use.

■ **Enhanced Treatments for Improving Vulnerable Road User Detection Within Mixed Fleets,** led by Jesse Eisert, was awarded in November 2023. This closed-course study is examining how various light treatments can help improve conventional and automated vehicle's ability to detect vulnerable road users. Data collection for this project is set to start Summer 2024.

THE ROAD AHEAD

Looking Forward

■ **Enhancing Vulnerable Road User (E-VRU) Detection and Volume Data Through Advanced Imaging Techniques,** led by Jesse Eisert. The research team completed two technical briefs; they are in the publication process and are expected to be published in Fall 2024. The final report is in development. The project evaluated the ability of light detection and ranging (LiDAR) sensors to detect vulnerable road users and collect accurate count data. This research also investigated LiDAR and infrared sensor fusion for detecting and counting vulnerable road users and compared the outcomes against the abilities of systems that use LiDAR only and thermal sensors only.

■ **Investigating Key Automated Vehicle (AV) Human Factors Safety Issues Related to Transportation System Management and Operations (TSMO),** led by Michelle Arnold.

» **Impact of Rainy Weather Condition on Driving Automated Driving System (ADS)-Equipped Vehicle in Mixed Vehicle Fleet** project is almost complete. The final technical report is expected to be published by Fall 2024.

This field study evaluates the effects of adverse weather on drivers using an ADS-equipped vehicle on an offsite track modified to simulate rainy conditions.

■ **Investigating Key Automated Vehicle (AV) Human Factors Safety Issues Related to Infrastructure,** led by Jesse Eisert.

» **Driver Interaction With Partial Driving Automation Technology When Passing Bicyclists in a Shared Use Lane.** The final technical report for the first FHWA Highway Driving Simulator is under internal review. This study explored the impact of vehicle automation on drivers' interactions with bicyclists in both shared and dedicated lanes.

» **Exploring the Effects of Automated Driving Systems and Cooperative Messaging on Mixed Fleet Eco-Drive Interactions.** The final technical report for the field study is under internal review. This study investigated a driver's reactions to following an SAE Level 3™ vehicle practicing eco-driving patterns in a signalized intersection.

THE ROAD AHEAD *(continued)*

» **Comparing Intersection Crossing Behavior of Human Drivers and Automated Vehicles Below and Above 10 mph (EZ Mile).** Using a CARMA℠ signal phase countdown timer prototype installed in a field research vehicle, the research team completed data collection and analysis. The final technical report is in development. The research team developed a model that compares the behavior of human drivers with that of a low-speed automated shuttle traveling on the same public roads.

Figure 2. Photo. Individuals testing out virtual reality in lab tour.

MILEPOSTS

Recent Activity

■ **Investigating Key Automated Vehicle (AV) Human Factors Safety Issues Related to Transportation System Management and Operations (TSMO),** led by Michelle Arnold.

» **Response to Emergency Vehicles When Driving in a Mixed Vehicle Fleet** project is complete. The final technical report (FHWA-HRT-24-063) was published in January 2024. This study evaluated the potential for cooperative technology and vehicle automation to influence driver's responses to emergency vehicles.

» **Effects of Work Zone Infrastructure on the Transition to Manual Driving** is complete. The final technical report (FHWA-HRT-24-117) was published in May 2024. This field study assessed the potential for work zone infrastructure to safely assist in transitioning vehicle control from an automated system to a human driver in advance of work zones.

■ **The Human Factors Issues Related to Truck Platooning** task order, led by Michelle Arnold, was completed in July 2023. The technical brief (FHWA-HRT-24-071) and the final technical report (FHWA-HRT-24-065) were published in January 2024. The results help develop guidance and recommendations for signing and operations of partially automated truck platoons in mixed-fleet environments on public highways.

■ **A Systematic Approach of Selecting Changeable Message Sign (CMS) Messaging During Nonrecurring Events,** led by Michelle Arnold, was completed in March 2023. The technical report and guidebook are in the FHWA publication process and are expected to be published Summer 2024. The purpose of this project was to determine how CMS messages affect travel behavior during nonrecurring events.

■ **Traffic Control Device (TCD) Consortium Pooled Fund Study (PFS). TPF-5(447),** led by Laura Mero.

» **Evaluation of Advisory Exit and Ramp Speed Signs.** The project's technical brief is in the FHWA publication process and is expected to be published Fall 2024. The objective of this project was to evaluate and provide information to designers of advisory exit and ramp speed warning signs, including the basis for speed designation, use of "exit" versus "ramp," effects of sign placement, and optimization of sign sequence.

■ **FHWA's Human Factors Vehicle Automation Research Article in** *Public Roads* **Summer Issue,** led by Michelle Arnold and Jesse Eisert. This article summarizes the role human factors play in automation research and provides a high-level outline of the research tools the team uses. This issue will be published Summer 2024.

■ **FHWA Highway Driving Simulator Indefinite Delivery Indefinite Quantity (IDIQ),** led by Michelle Arnold, was awarded Fall 2023. The contract allows for onsite technical support to operate, maintain, and, as required, enhance the Highway Driving Simulator (HDS) in support of human factors research. As part of enhancing the HDS, a task order was awarded to upgrade the operation console and testbed area of the HDS lab.

HUMAN FACTORS LABORATORY TOURS

The Human Factors team hosted numerous tours throughout this year. Some of these tours included:

- Office of Safety.
- Operational Support Team Military Partners.
- Delegation of Flanders.

- George Washington University.
- Asian Development Bank.
- U.S. Air Force Fellowship.
- Korean Delegates.
- Bring Your Child to Work Day.

CONFERENCES

Conferences Attended

- **Transportation Research Board Annual Meeting,** January 7–11, 2024. Washington, DC.

  » Demonstrated ongoing vulnerable road user research and connected and automated vehicle education (CAVe)-in-a-box through an interactive demonstration with the VR simulator and headsets as well as an articulating pedestrian dummy at a crosswalk equipped with infrastructure-based sensors at the exhibit hall.

  » *Effects of Signing and Configuration of Partially Automated Truck Platooning on Light-Vehicle Driver Behavior.* Poster.

  » *Drivers' Mobile Usage of Information and Communication Technologies (ICT) in 2020 and 2023.* Poster.

  » *ACH40; Human Factors of Infrastructure Design and Operations.* Project updates on vulnerable road user safety.

- **National Committee on Uniform Traffic Control Devices Annual Meeting January 10–12, 2024. Arlington, VA.** Provided updates on the TCD Pooled Fund Studies and other relevant projects.

- **Safe Mobility Conference, March 25–26, 2024, Chapel Hill, NC.** Attended sessions and a workshop focused on achieving safer mobility for all road users.

Source: FHWA.

Figure 3. Photo. Individual testing virtual reality at TRB Annual Meeting 2024.

- **National Association of City Transportation Officials (NACTO) Designing Cities 2024, May 7–10, 2024. Miami, FL.** Attended sessions and a workshop focused on Complete Streets for all road users.

- **Intelligent Transportation Systems of America Conference and Expo, April 22–24, 2024, Phoenix, AZ.** Presented information about the Intersection Safety Challenge.

Upcoming Conferences

- **Institute of Transportation Engineers Annual Meeting and Expo, July 21–24, 2024, Philadelphia, PA.**

- **Transportation Research Board Automated Road Transportation Symposium, July 29–August 1, 2024, San Diego, CA.**

U.S. Department of Transportation
Federal Highway Administration