FAST LANE

Exploring Human Behavior

HUMAN FACTORS

Turner-Fairbank
Highway Research Center

Safety R&D Program
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Hot Off the Press

Ahmed, A., S. Weaver, S. F. Chao, and L. Mero. 2023. *Evaluation of Additional Alternatives of, and Arrow Sizes for, Overhead Arrow-Per-Lane Guide Signs*. Report No. FHWA-HRT-23-036. Washington, DC: Federal Highway Administration. https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA-HRT-23-036.pdf, last accessed November 13, 2023.

Dixon, K., R. Avelar-Moran, S. Mousavi, and A. Do. 2023. *Developing Crash Modification Factors for Separated Bicycle Lanes*. Report No. FHWA-HRT-23-025. Washington, DC: Federal Highway Administration. https://highways.dot.gov/research/publications/safety/FHWA-HRT-23-025, last accessed November 13, 2023.

Dixon, K., R. Avelar-Moran, S. Mousavi, and A. Do. 2023. *Developing Crash Modification Factors for Separated Bicycle Lanes*. Report No. FHWA-HRT-23-078. Washington, DC: Federal Highway Administration. https://highways.dot.gov/research/publications/safety/FHWA-HRT-23-078, last accessed November 13, 2023.

Fitzpatrick, K., A. Do, R. Avelar, M. Pratt, and S. Das. 2022. "Improving Pedestrian Safety at Signalized Intersections: Impacts of Corner Radius." *ITE Journal* 92, no. 6:37–43. https://ite.ygsclicbook.com/pubs/itejournal/2022/june-2022/live/?i=true#p=4, last accessed November 13, 2023.

Fitzpatrick, K., S. E. Park, N. Johnson, and K. Falk. 2023. *Driver Yielding with LED-Embedded Pedestrian- and School-Crossing Signs*. Report No. FHWA-HRT-23-038. Washington, DC: Federal Highway Administration. https://highways.dot.gov/research/publications/safety/FHWA-HRT-23-038, last accessed November 13, 2023.

Katz, B., E. Kissner, E. Filler, S. Jackson, C. Vaughan, C. Cunningham, and J. Eisert. 2023. *Evaluation of Lane Reduction and Late Merge Signing*. Report No. FHWA-HRT-23-070. Washington, DC: Federal Highway Administration. https://highways.dot.gov/research/publications/safety/FHWA-HRT-23-070, last accessed November 13, 2023.

Parker, J., J. D. Lee, T. McDonald, P. Rau, and B. Philips. 2023. "Do Researchers Use the Levels of Automation Appropriately? How Automation Is Discussed in Research." In Proceedings of the Human Factors and Ergonomics Society Annual Meeting. Los Angeles, CA: SAGE Publications.

Weaver, S.W., S. Chao, M. Jannat, B. Philips. 2022. *Preferred Following Distance as a Function of Speed— Function-Specific Automation (Level 1) Applications*. Report No. FHWA-HRT-22-107. Washington, DC: Federal Highway Administration. https://highways.dot.gov/research/publications/safety/FHWA-HRT-22-107, last accessed November 13, 2023.

TRAVEL LANE

Current Research:

■ **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** project has finished pilot testing. This simulator study aims to help transportation agencies assess the impact of mixed fleets on traffic safety and congestion at on-ramp merge points.

■ **Investigating Key Automated Vehicle 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** project has finished pilot testing. This simulator study aims to help transportation agencies assess the impact of mixed fleets and connected infrastructure on traffic safety at lane closures.

» **Comparing Intersection Crossing Behavior of Human Drivers and Automated Vehicles Below and Above 10 mph (EZ Mile)** project collected data using a novel CARMA℠ signal phase countdown timer prototype installed in a field research vehicle. The research team collected data on a public roadway in live traffic and developed a model to compare the behavior of human drivers with that of a low-speed automated shuttle traveling on the same public roads.

■ **Enhancing Vulnerable Road User (E-VRU) Detection and Volume Data Through Advanced Imaging Techniques** project, led by Jesse Eisert, has completed daytime and nighttime data collection using light detection and ranging (LiDAR) and thermal infrared sensors to detect different vulnerable road user (VRU) types, including an articulating child pedestrian dummy, human pedestrian, electric scooter rider, bicyclist, and wheelchair user. The project will evaluate the ability of LiDAR sensors to detect VRUs and collect accurate count data. This research will also investigate LiDAR and infrared sensor fusion for detecting and counting VRUs and compare the outcomes against the abilities of systems that use only LiDAR and only thermal sensors.

■ **Traffic Control Device (TCD) Consortium Pooled Fund Study (PFS) (TPF-5(447),** led by Laura Mero, has been very busy and continues to welcome new member States. Members approved the new charter and appointed a new chair at the September 2023 annual meeting in Albuquerque, NM. The project selection process was initiated. Problem statements for the potential new projects will be posted on the pooledfund.org web page for this PFS under documents.

» **Evaluation of Advisory Exit and Ramp Speed Signs** project has completed all data collection and analysis. The technical brief is in

TRAVEL LANE *(continued)*

development and will be published in 2024. The objective of this project is to evaluate and produce uniform recommendations to designers for 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.

» **Pedestrian Signing at Uncontrolled Crossings** project began collecting field data after completing computer-based testing data collection and analysis. 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** project began in September 2023. The objective of this research is to evaluate the possibility of creating a symbol where one does not exist and review legibility and comprehension for new and existing symbol- 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) Vulnerable Road Users Safety Through Infrastructure: Phase 2** project, led by Jesse Eisert, began data collection in the Turner-Fairbank Highway Research Center Virtual Reality (VR) Laboratory. This project examines infrastructure-based solutions for VRU interactions with CDA-equipped vehicles using VR.

■ **Exploring Potential Contributors to Racial and Socioeconomic Disparities in Pedestrian and Bicyclist Morbidity and Mortality** project, led by Jesse Eisert, has successfully convened a subject matter expert panel to provide input, recommendations, and feedback throughout this project. The research team has completed the first draft of the literature review and provided feedback. Additionally, the case studies for this project have been selected and are being further explored and developed.

■ **Evaluation of Crosswalks with Surface Treatments Phase II** project, led by Laura Mero, began in September 2023. The objectives of the project are to determine if crosswalks with surface treatments affect road user (drivers and pedestrians, including those with visual impairments) behavior compared to standard crosswalk markings and what conditions

Figure 1. Photo. Weather study data collection shows participant and lead vehicle driving on the test track.

and aspects of the crosswalks with surface treatments impact road user behavior. This project will take place in the field and is in the early planning stages. This project is a follow up to **Evaluation of Aesthetically Treated Crosswalks**, which shared the same objectives and took place in closed course environments.

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

■ **Development of a Virtual Reality Bicycle Simulator** study, led by Jesse Eisert, began in September 2023. This project will develop a VR bicycle capable of conducting human factors research along with training materials for using and developing scenarios for the VR bicycle.

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![FAST LANE biannual highlights — HUMAN FACTORS]

THE ROAD AHEAD

Looking forward

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

  » **Effects of Work Zone Infrastructure on the Transition to Manual Driving** project is almost complete. The final technical report is expected to be published in summer 2024. This field study assesses 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.

  » **Response to Emergency Vehicles When Driving in a Mixed Vehicle Fleet** project is almost complete. The final technical report is expected to be published in spring 2024. This study evaluates the potential for cooperative technology and vehicle automation to influence driver's response to emergency vehicles.

  » **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 in spring 2024. This field study evaluates the effects of adverse weather on drivers using an ADS-equipped vehicle on an offsite track modified to simulate rain.

Figure 2. Photo. Truck platooning study data collection and truck platooning simulation.

Source: FHWA.

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

  » **Driver Interaction With Partial Driving Automation Technology When Passing Bicyclists in a Shared Use Lane** project is under internal review. This study explores 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** project final technical report for the field study is under internal review. This study investigated driver's reactions to following an automated vehicle practicing eco-driving patterns in a signalized intersection.

MILEPOSTS

Recent activity

- **The Human Factors Issues Related to Truck Platooning** task order, led by Michelle Arnold, was completed in July 2023. The technical brief summarizing the driving simulator studies and the final technical report compiling all the project studies are expected to be published by Spring 2024. The results can help develop guidance and recommendations for signing and operations of partially automated truck platoons in mixed-fleet environments on public highways.

- **Evaluation of Lane Reduction and Late Merge Signing** project, led by Jesse Eisert, was completed in July 2023, as part of the TCD PFS (FHWA-HRT-23-070). The technical brief summarizing the laboratory and field studies is available online. The results showed the sign series studied in the field increased the primary measure of right lane use.

- **A Systematic Approach of Selecting Changeable Message Sign (CMS) Messaging During Nonrecurring Events** project, led by Michelle Arnold, was completed in March 2023. The research team completed data collection, a technical report, and a guidebook, which are in the FHWA publication process. The project's purpose is to determine how CMS messages impact travel behavior during nonrecurring events.

- **Evaluation of Arrow Sizes for Overhead Arrow Per Lane (OAPL) Guide Signs** (FHWA-HRT-23-036), led by Laura Mero, was completed in March 2023. The published final report is published and publicly available. This project examines partial-width OAPL sign designs and arrow sizes and the effects these characteristics have on driver comprehension.

MILEPOSTS *(continued)*

- **Developing Crash Modification Factors for Separated Bicycle Lanes** (FHWA-HRT-23-078), led by Ann Do, was completed in September 2023. The published final report is publicly available. This project investigates how conversions of a traditional bicycle lane to a separated bicycle lane influence the safety performance of the roadway.

HUMAN FACTORS LABORATORY TOURS

The Human Factors team hosted several tours throughout the year, including:

- Department of Transportation Executives (Deputy Secretary Trottenberg, Administrator Bhatt, and FHWA Executive Director Shepherd).

- FHWA Office of Administration.

- White House Leadership.

- National Transportation Safety Board.

- National Highway Traffic Safety Administration, Office of Human Resources.

- FHWA Research Division Coordinators and the National Cooperative Highway Research Program.

Source: FHWA.

Figure 4. Photo. Comparing intersection crossing behavior of human drivers and AVs below and above 10 mph, data collection featuring the in-vehicle signal phase countdown timer during the dilemma zone.

Source: FHWA.

Figure 3. Photo. Tour with DOT Executives (Deputy Secretary Trottenberg, Administrator Bhatt, and FHWA Executive Director Shepherd).

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CONFERENCES

Conferences Attended

- **Transportation Research Board (TRB) Annual Meeting,** January 8–12, 2023. Washington, DC.

- **Intelligent Transportation Systems of America Conference and Expo,** April 24–27, 2023. Grapevine, TX. "Infrastructure Safety Deployments of Connected Vehicle Technologies." Presentation.

- **American Association of State Highway and Transportation Officials Committee on Traffic Engineering Meeting,** June 25-28, 2023. Tacoma, WA.

- **National Committee on Uniform TCDs Summer Meeting,** June 28–30, 2023. Tacoma, WA.

- **TRB Automated Road Transportation Symposia,** July 9–13, 2023. San Francisco, CA. (Effects of Signing and Characteristics of Partially Automated Truck Platooning on Light-Vehicle Driver Behavior). Poster.

- **Institute of Transportation Engineers International Annual Meeting and Expo,** August 13–26, 2023. Portland, OR. (Trust in Automation and Cooperative Messaging: Interacting with Economical Driving). Poster.

Upcoming Conferences

- **TRB Annual Meeting,** January 7–11, 2024. Washington, DC.

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

  » Standing Committee on Human Factors of Infrastructure Design and Operations (ACH40); Human Factors of Infrastructure Design and Operations. Project updates on VRU safety.

  » (Effects of Signing and Characteristics of Partially Automated Truck Platooning on Light-Vehicle Driver Behavior). Poster.

- **National Committee on Uniform TCDs Annual Meeting,** January 10–12, 2024. Arlington, VA.

- **Intelligent Transportation Systems of America Conference and Expo,** April 22–25, 2024. Phoenix, AZ.

Figure 5. Photo. Tour with the National Transportation Safety Board.

- **Human Factors and Ergonomic Society 67th International Annual Meeting,** October 23–27, 2023. Washington, DC.

  » (Study on Cooperative Driving Automation Messaging Designs). Poster.

  » "Driving Automation and VRUs: Peanut Butter and Jelly or Oil and Water?" Panel.

  » (Do Researchers Use the Levels of Automation Appropriately? How Automation Is Discussed in Research). Poster.

Meet the Team

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Leidos, Human Factors onsite support.

Syntek Technologies, Highway Driving Simulator onsite support.