DRISI
Caltrans Division of Research, Innovation and System Information

# Research Notes

## Developing Engineering Countermeasures for Wrong Way Driving (WWD)

Identifying methods to communicate wrong way information to severely intoxicated drivers leading to the development of effective engineering countermeasures.

Transportation Safety and Mobility

FEBRUARY 2023

Project Title:
Wrong Way Driver Mitigation

Task Number: 3705

Start Date: September 1, 2019

Completion Date: May 1, 2023

Task Manager:
John Slonaker
Sr. Transportation Electrical Engineer (Specialist)
john.slonaker@dot.ca.gov

### WHAT IS THE NEED?

Wrong-way collisions account for only about 3 percent of accidents on high-speed divided highways, but they are much more likely to result in fatalities than other types of highway crashes. Most wrong-way events on controlled-access highways are head-on collisions caused by drivers who are severely intoxicated.

Research has consistently identified the cause of many wrong way driving collisions as drivers whose blood alcohol content is twice or more than the legal limit of 0.08 percent, often 0.20 and higher. Current countermeasures include installation of larger signs at driver sight level, flashing beacons, and retroreflective pavement markings. Research indicates these countermeasures are effective in producing self-corrective actions of wrong way driver movements when the driver is not intoxicated, but that they have had little to no effect on reducing wrong way collisions caused by severely intoxicated drivers.

Current countermeasures require a certain level of cognitive ability to see the countermeasure, recognize what it means, and take appropriate action. The proposed research seeks to understand the cognitive abilities of severely intoxicated drivers as a first step in developing effective engineering countermeasures to prevent severely intoxicated drivers from entering highways in the wrong direction and causing fatal collisions.

### WHAT ARE WE DOING?

Caltrans contracted with researchers in the Engineering and Psychology departments at Auburn University to design and conduct a study to investigate the effectiveness of countermeasures specifically designed for intoxicated wrong

way drivers. These include bidirectional pavement markings and directional rumble strips, which generate vibrations to provide haptic feedback alerts to intoxicated drivers who may not be able to recognize visual warnings. The researchers used human subjects in a driving simulator to test their responses to these emerging countermeasure technologies in comparison to more standard methods such as Do Not Enter/Wrong Way signs, type V arrows and two-way retro-reflective raised pavement markings based on Caltrans Manual for Uniform Traffic Control Devices (MUTCD) requirements.

In order to conduct this study, the Psychology Department researchers obtained approval to administer alcohol to human test subjects from Auburn University. The Engineering Department researchers designed and programmed virtual road networks into the driving simulator and developed simulation models for the proposed new WWD countermeasures and more standard methods. The Psychology department researchers operated the driving simulator and directed the test subjects through the testing process. The Engineering Department researchers recorded the driving behavior of the subjects and analyzed it to determine the effectiveness of the various countermeasures.

## WHAT IS OUR GOAL?

The proposed research seeks to understand the cognitive abilities of severely intoxicated drivers as a first step in developing effective engineering countermeasures to prevent severely intoxicated drivers from entering highways in the wrong direction.

## WHAT IS THE BENEFIT?

Although this task is in the conceptual stage, focusing on which types of stimuli most affect severely intoxicated drivers, future study could use its findings to develop and deploy engineering countermeasures to prevent wrong way entries onto state highways. This would align with the Caltrans' Strategic Goal of Safety and Health.

## WHAT IS THE PROGRESS TO DATE?

The contract between Caltrans and Auburn University was signed by Caltrans' Division of Procurement and Contracts (DPAC), and the project manager held a kick-off meeting with the Auburn researchers and the Caltrans project panel. The research team obtained approval to administer alcohol to human test subjects from Auburn University's Institutional Review Board (IRB).

The researchers updated all the software used by the driving simulator to the latest version. They then programmed the virtual road networks for three testing scenarios and one training scenario into the driving simulator. They also developed simulation models for the proposed new WWD countermeasures, including the "Lane Alert 2X" wrong way pavement arrows and Directional Rumble Strips (DRS), and existing countermeasures, including Do Not Enter/Wrong Way signs, type V arrows and two-way retro-reflective raised pavement markings based on Caltrans Manual for Uniform Traffic Control Devices (MUTCD) requirements.

The researchers conducted a training session for the research assistants to familiarize them with the ethical and safe treatment of participants and data, operating the driving simulator and the eye-tracking devices, and guiding participants through the entire testing procedure before the actual lab testing session began.

The researchers recruited 64 candidate subjects who met the criteria for inclusion in the study and chose 30 of them to complete all three sessions (simulator training, three countermeasure recognition scenarios while sober and three countermeasure recognition scenarios while intoxicated) of the driving simulator. The driving simulator presented the subjects with various mixtures of countermeasures in order to

compare the effectiveness of current standard countermeasures, as defined in the MUTCD and CAMUTCD, with the emerging non-standard methods. The researchers recorded all the driving behavior and eye movements from the driving simulator and eye-tracking devices of the for analysis.

Work planned for next quarter:

The Researchers will compile their analysis of all collected data and present their findings in a final report. They will also present their findings at a "Research Connection" webinar (facilitated by Caltrans' Division of Research, Innovation and System Information) on April 19th, 2023.

## IMAGES

Image 1: Driving simulator

Image 2: Participant's view of driving simulator

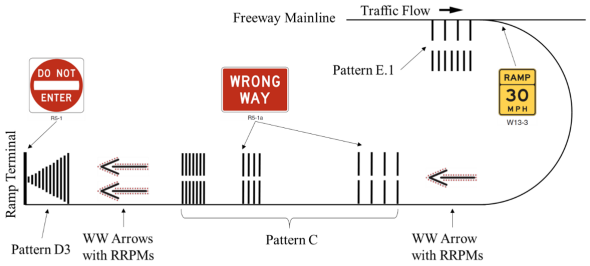


Image 3: Directional rumble strip patterns

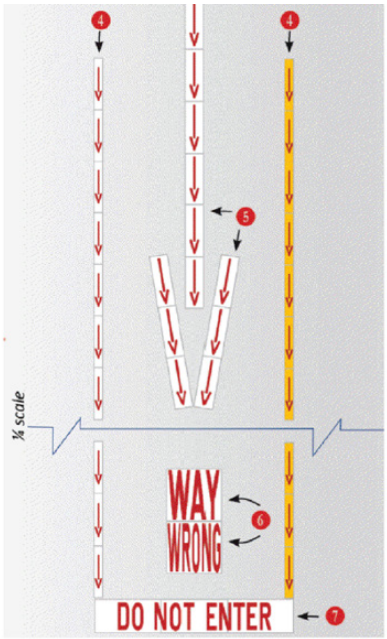


Image 4: Lane Alert 2X bi-directional countermeasure


Image 5: Enlarged DO NOT ENTER and WRONG WAY signs

Image 6: Directional rumble strip pattern D3 installed in the field