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UTC Spotlight

University Transportation Centers Program

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The Joint Merge: Improving Work Zone Traffic Flows

Stopping traffic flow to perform road maintenance is not always feasible. Common practice is to close a lane for maintenance and guide traffic to an open lane through the work zone. Unfortunately, it is well recognized that lane closures create safety hazards for drivers and workers, create congestion and delays, and reduce highway capacity. However, new research at Louisiana State University (LSU) is investigating how novel and innovative traffic control strategies can improve traffic flow and safety by facilitating merges leading up to lane closures.

Prior research has shown that the commonly used "conventional" lane merge design (CLM), specified in the *Manual on Uniform Traffic Control Devices* (MUTCD), can create long queues during peak hours and large numbers of rear end and side swipe crashes. This project, funded by USDOT through the Gulf Coast Center for Evacuation and Transportation Resiliency at LSU, examined the interactions between driver characteristics and behavior with traffic control configurations. The main focus was to measure the performance of a recently developed merge design known as *Joint Lane Merge* (JLM) in terms of its effects on driver behavior. The research results provide a better understanding of how individual differences and driver behavior can influence driver safety, and it is hoped that these findings can be used to improve traffic flow in construction zones and evacuation plans.

The Joint Lane Merge Concept

In the JLM configuration (figure 1), motorists in both lanes have equal right-of-way, as opposed to CLM where the open lane maintains right-of-way priority through the closure. Blinking arrow signs on both sides of the road convey guidance to drivers by guiding them to merge using an alternating pattern of lane changes within the transition area. It is based on the Ritsen ("zipping") concept that has been applied for many years in The Netherlands.

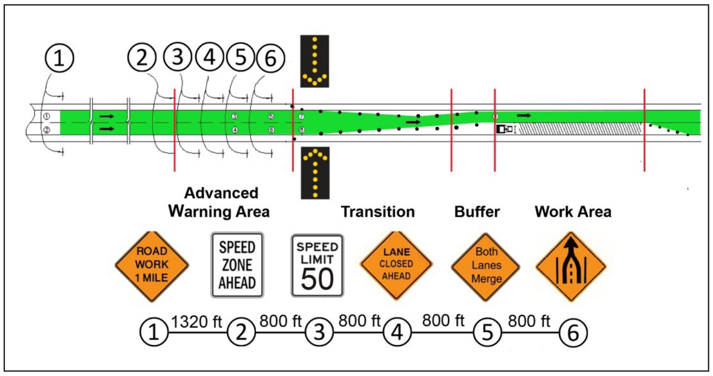

Figure 1: Joint Lane Merge Traffic Control Design

Research Methods and Results

To study the efficiency of JLM, a full-scale passenger car simulator surrounded by four screens showing front, rear, left, and right views was utilized (figure 2). A model was developed to represent a common work zone situation on an interstate highway, and JLM and CLM designs were used to simulate merging behavior. Each design was tested for two levels of traffic density (high and low) and three different lengths of advanced warning area. Performance measures that included average speed, maximum braking force, average deceleration, and distance of changing lane from the beginning of the transition zone were collected by using the driving simulator. Thirty university students with valid driver licenses participated in the study.

From a human factors perspective, occupational injuries and incidents are the result of poor task and work place design, which leads to errors, accidents, and lowered productivity. Similarly, driving through work zones can be physically, mentally, and temporally demanding as a result of performing physical and cognitive tasks under time pressure. To increase safety, health, comfort, and long-term efficiency of drivers in work zones, one of the goals of the JLM was to regulate task demands to prevent overloading drivers.

To test this concept, various driving related task demands were measured by asking each participant, after driving through the molded work zone with CLM or JLM design, to rate the mental, physical, and temporal demands involved in the task as well as the level of frustration, performance, and effort experienced. The analysis of workload measurement showed that overall, participants who tested both JLM and CLM preferred JLM.

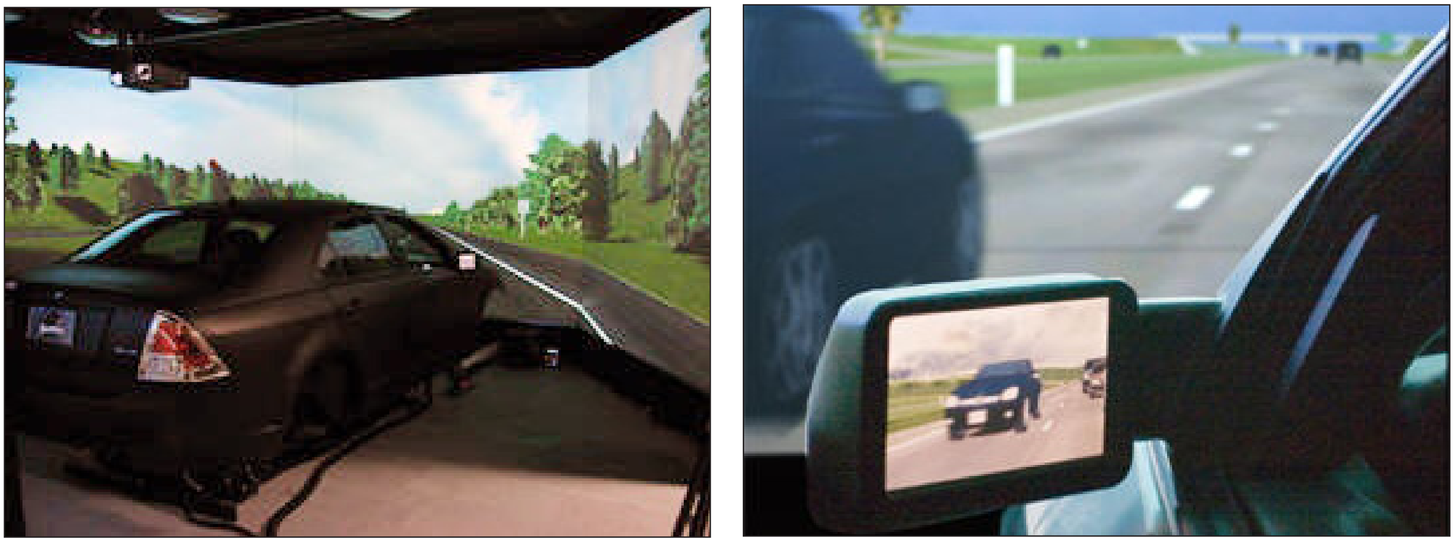

Figure 2. View of Driving Simulator

Results showed that JLM required less mental activity, and participants completed the merge with ease and free from any time pressure associated with other merging vehicles. Moreover, driving through JLM required less effort and participants were more satisfied with their performance.

The analysis of simulator data also showed that JLM outperformed CLM. Average vehicle operating speed, deceleration, and braking force were all lower in JLM. The greatest difference between the JLM and CLM designs were the merging speeds at low traffic volumes. At low volumes, merging speeds in the JLM were 6 percent higher than in CLM. Average braking force and deceleration in JLM were 34 percent lower than those in CLM. With respect to the distance of merge from the beginning of the transition zone, drivers in CLM stayed in the closed lane longer, on average started to merge 1,090 ft. prior to the transition zone as compared to 1,950 ft. for the JLM.

Potential Benefits of the Project

This study showed that drivers have lower demands, exert less effort, and have higher satisfaction with driving performance when using the joint lane merge design (JLM). These findings match the simulator results showing better driving performance in terms of speed and braking patterns with the JLM. The results of this study and subsequent studies are anticipated to enable designers and planners to better regulate the flow of traffic and increase driver satisfaction and safety within work zone lane closure merge areas. This research suggests that the JLM can increase safety, reduce congestion near work zones, increase speed and road capacity, and ultimately save drivers' time.

About This Project

This research was led by Fereydoun Aghazadeh, Ph.D., CPE, and Laura Ikuma, Ph.D. in LSU's Department of Civil and Environmental Engineering and LSU's Department of Mechanical and Industrial Engineering and supported by the *Southwest Region University Transportation Center* through one of its consortium members the *Gulf Coast Research Center for Evacuation and Transportation Resiliency* (CETR). For additional information about this and other related projects in the *Southwest Region University Transportation Center*, visit the website at: swutc.tamu.edu, or contact Fereydoun Aghazadeh at: aghazadeh@lsu.edu, Laura Ikuma at: likuma@lsu.edu, or the CETR Director, Brian Wolshon at: brian@rsip.lsu.edu.