Project Summary

Texas Department of Transportation

0-5911: Driver Workload and Visual Studies

Background

Geometric design guidance has traditionally existed for speeds ranging from 15 to 80 mph. Potential values for geometric elements designed for 85 to 100 mph speeds were developed in a recent research project conducted for the Texas Department of Transportation (TxDOT) and are now in the TxDOT *Roadway Design Manual*. Because of limited previous research, the project relied upon extrapolating from previous research and using engineering judgment to develop the criteria. One area that was identified as needing additional research was driver workload at higher speeds.

It is possible that driver workload could increase with higher speeds, leading to a slowed reaction time to hazards. In other words, at high speeds it may be that the driver is paying so much attention to the basic task of vehicle control that he or she may be slower in responding to hazards. On the other hand, driver vigilance may increase with higher speeds, leading to equal or faster reaction times. In addition to reaction time, the driver must be able to see an impending object, both in the daytime and in the nighttime.

The type of object that the driver is likely to encounter is typically another vehicle, one which may be traveling at a slower speed. The rate of change of an image in terms of visual angle is very slow at far distances. The ability to perceive an upcoming target in the visual field—e.g., approaching a slow-moving vehicle from behind—depends on a driver's ability to detect that the image size is changing, which does not occur until fairly close distances. Therefore, at high speeds drivers will not have much time to decelerate or maneuver out of the way.

What the Researchers Did

The project objectives were achieved through a series of research tasks. Within those tasks, researchers explored several methods as part of this project to assist in gaining a better understanding of driver performance at high speeds. This project used the following research studies:

- **Closed-Course Pilot Study** consisted of observing and recording the activities and actions of a series of drivers following a lead vehicle going either 60 or 85 mph.
- **Open-Road Pilot Study** recorded participants driving between Odessa and Pecos, Texas, within 70 mph and 80 mph sections.
- **Simulator Pilot Study** determined driver reactions to an upcoming vehicle (both passenger car and large truck) and also generated directions for how to conduct the Phase II simulator study.

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- **Simulator Phase II Study** collected brake reaction to a vehicle in the driver's view for 50 participants. Conditions varied including initial speed, lead-vehicle type, lead-vehicle deceleration rate, and workload level.
- **Following Distance Study** used data from traffic counters to identify speed and axle gap data on freeways with 60, 70, and 80 mph posted speed limits.
- **Gaps at Passing Study** measured gaps during passing maneuvers for daylight conditions on freeway sections.

What They Found

The simulator studies supported previous research in finding that drivers will steer away from an obstacle in their lane rather than engage in a panic stop situation. When responding to a vehicle slowing in their lane, the reaction time of drivers in the simulator study at the 85 mph speed was statistically longer than drivers at the 60 mph speed. Drivers took more time at the higher speed to respond to a lead vehicle slowing in their lane. The traffic counter data showed that axle clearance distance was larger for the 80 mph freeway sites as compared to the 60 and 70 mph speed limit sites, both statistically and practically.

The passing gap study found a different result. Drivers used similar passing-gap distances on both 70 mph and 80 mph sections. Drivers passed more closely to the larger vehicle (recreational vehicle) than the smaller vehicle (sedan). Passing gap increases by 10 ft for each mph increase in speed difference between the lead vehicle and the following vehicle. The faster a driver approaches a vehicle, the greater the passing-gap distance.

What This Means

In the simulator and test-track studies that directly measured driver performance, evidence is present that performance declines when a driver is multi-tasking at higher speeds. For tasks such as mental arithmetic in the simulator and detecting a peripheral light while changing a CD on the test track, reaction time to lead-vehicle deceleration was longer at the higher speeds. Researchers interpreted this to mean that driving at the higher speed was more challenging. The simulator study, in particular, showed that driving 85 mph required more mental effort than driving 60 mph, leaving less mental capacity free to do the arithmetic problems.

These laboratory and controlled test-track tasks are likely relatively easy compared to the type of multi-tasking drivers may do on actual roads. For safety reasons, this project was not able to overload drivers on the open road and test track by giving them tasks such as cell phone conversations, navigation system interactions, etc. For this reason, the results of these driver performance studies should be taken to be at the low end of a scale of driver distraction. Driving performance may decline even further in situations where drivers are engaging in other physically or mentally distracting tasks.

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