TechBrief

Programs of the Federal Motor Carrier Safety Administration (FMCSA) encompass a range of issues and disciplines related to motor carrier safety and security. FMCSA's Office of Analysis, Research, and Technology defines a "research program" as any systematic study directed toward fuller scientific discovery, knowledge, or understanding that will improve safety, and reduce the number and severity of commercial motor vehicle crashes. Similarly, a "technology program" is a program that adopts, develops, tests, and/or deploys innovative driver and/or vehicle best safety practices and technologies that will improve safety and reduce the number and severity of commercial motor vehicle crashes. An "analysis program" is defined as economic and environmental analyses done for agency rulemakings, as well as program effectiveness studies, state-reported data quality initiatives, and special crash and other motor carrier safety performance-related analyses. A "large truck" is any truck with a Gross Vehicle Weight rating or Gross Combination Weight rating of more than 10,000 pounds.

Currently, the FMCSA Office of Analysis, Research, and Technology is conducting programs in order to produce safer drivers, improve safety of commercial motor vehicles, produce safer carriers, advance safety through information-based initiatives, and improve security through safety initiatives. The study described in this Tech Brief was designed and developed to support the strategic objective to produce safer drivers. The primary goals of this initiative are to ensure that commercial drivers are physically qualified, trained to perform safely, and mentally alert.

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Showcase of Advanced Simulator Capabilities for Training and Testing Commercial Motor Vehicle Drivers

Background

The Federal Motor Carrier Safety Administration (FMCSA) is dedicated to reducing the incidence and severity of commercial motor vehicle (CMV) crashes. In 2008, crashes involving large trucks accounted for 4,229 fatalities with an additional 90,000 injuries (National Highway Traffic Safety Administration, Fatality Analysis Reporting System, 2010). Only 16 percent of those fatalities and 26 percent of those injured were the occupants of large trucks. Thus the mission of the FMCSA to promote the safe operation of CMVs not only benefits the commercial transportation industry and CMV drivers but also the safety of the general public. It is widely recognized that the operation of a CMV requires a variety of specialized skills and knowledge. However, CMV drivers may not practice or experience situations requiring these skills on a regular basis. Due to this, refresher and defensive driving training and testing of CMV drivers may be valuable.

Scope

The Advanced Capabilities Showcase (ACS) was a demonstration of how state-of-the-art driving simulators can be used in CMV defensive driving training and testing. These advanced capabilities include the ability to simulate emergency maneuvers and extreme driving conditions along with different vehicle configurations (e.g., vans, tankers, and doubles). This showcase had two primary goals: explore the realism and effectiveness of each simulated emergency maneuver and extreme driving condition; and demonstrate the ability to assess driver performance during simulated emergency maneuvers and extreme driving conditions while examining driver performance based on experience level.

The Simulator

An FAAC, Inc. model TT-2000-V7 + 3 DOF tractor-trailer simulator was used (Figure 1). Computer-generated imagery is displayed on five 60-inch screens through projectors surrounding a generic truck cab to provide a seamless 225 degree forward field of view. Actual flat mirrors reflect images from plasma monitors mounted behind the cab in order to provide parallax for the driver. The cab has original equipment manufacturer working gauges, indicator and warning lights, pedals, and shifter with range selector. The seat provides heave, pitch, and roll based on environmental conditions and driver inputs to the vehicle controls. Force feedback steering is used to provide tactile feedback for different road surfaces, resistance at different road speeds, and curb strikes. Tractor and trailer characteristics and dynamics, along with the driving environment, can be manipulated to create specific, customized scenarios. A library of automobiles, trucks, buses, pedestrians, signs, buildings, and other objects is available to further

enhance scenarios. In addition, the simulator provides the ability to give overhead views and instantly halt the driving scenario, as well as replay or re-drive the prior 30 seconds of the scenario.

Figure 1. *The FAAC truck simulator cabin and controls.*

Methods

A total of 48 Class A commercial driver's license (CDL) drivers with differing levels of on-the-job experience were recruited to participate in the ACS. Based on consultations with subject-matter experts, drivers for this study were grouped into million-miler drivers and non-million-miler drivers. Million milers were defined as drivers with 1 million miles or more logged with no at-fault crashes. Non-million milers are drivers with less than 1 million miles logged and/or any driver with any at-fault crashes. Three trailer configurations were showcased: 53-ft. van, 48-ft. tanker, and a standard set of 28-ft. doubles. Drivers were recruited who primarily drove one of the three trailer configurations at his/her place of employment. Ten non-million milers and six million milers were recruited for each trailer configuration.

ACS participants completed a simulator orientation (including information on the various controls and adjustments of the simulator) and two orientation drives. After orientation, participants began the ACS showcase scenario. A conventional tractor with a 10-speed

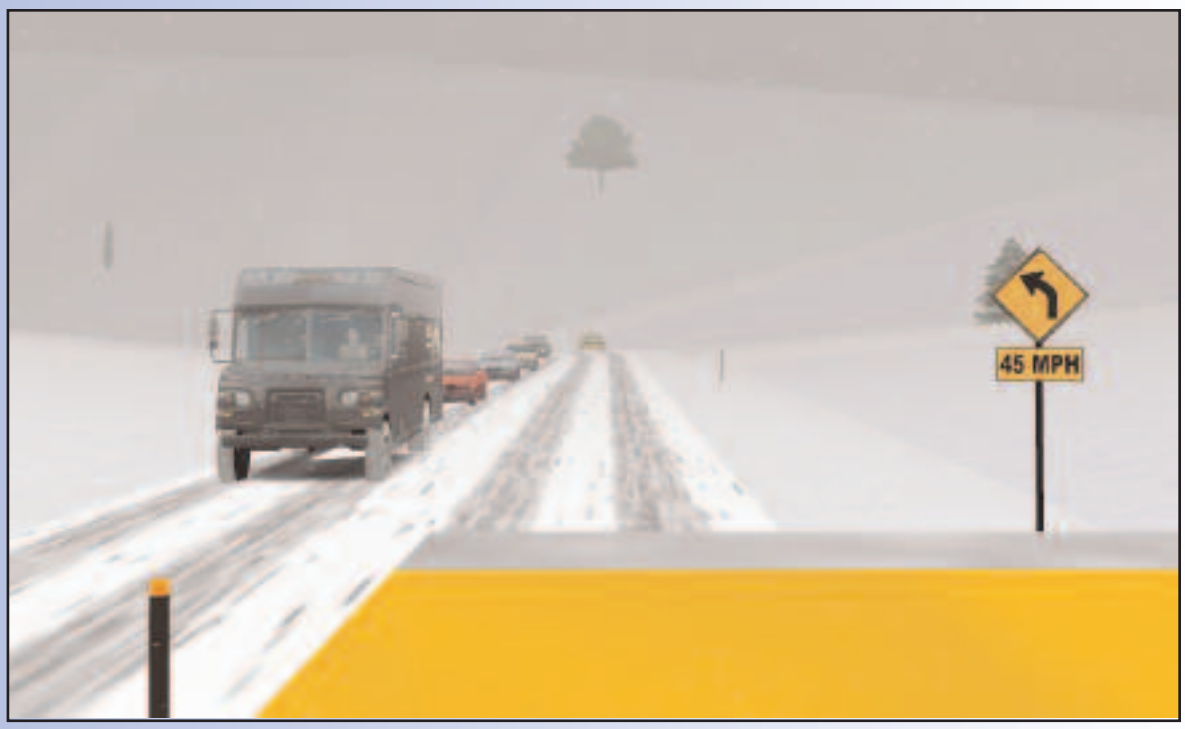

Figure 2. Simulated 8 percent downgrade winter driving

double-clutching transmission was used in conjunction with one of the three trailer configurations. The trailer type selected was dependent on the trailer the participant primarily pulls at his/her place of employment. The van and doubles trailers were fully loaded to their gross vehicle weight rating (GVWR) of 80,000 pounds while the tanker trailer (with one baffle) was half loaded with 4,000 gallons.

The ACS showcase scenario consisted of routine driving along with 12 emergency situations and 10 extreme conditions as shown below.

Emergency Maneuvers	Extreme Conditions
Merge Squeezes.	Fog.
Lane Crosses.	Rain.
Steering Tire Blowout.	Snow.
Rollovers (Both Left and Right).	Black Ice.
Brake failures.	8% Upgrades.
Evasive Maneuvers.	8% Downgrades (Dry).
Animal Crossings.	8% Downgrades (Snow).
Blind Entrances.	Dirt Roads.
Pedestrians.	Construction Zones.
Tight City Turns.	Railroad Crossings.
Roadway Obstructions.	–

The experimenter provided verbal driving directions while scoring the participant. The experimenter only announced which roads to take and did not cue the driver to any pending events. In the event of a crash, the experimenter had a remote control that allowed the scenario to be restarted at the point 30 seconds before the crash occurred. At the end of the ACS scenario, the participant exited the simulator and completed a questionnaire.

Key Findings

Following the completion of the driving scenario, both million-miler and non-million-miler participants across all three trailer configurations provided ratings on the realism of the emergency maneuvers and extreme driving conditions. These ratings included “extremely unrealistic,” “unrealistic,” “about the same,” “realistic,” and “extremely realistic.” Average ratings were calculated for each of the 12 emergency maneuvers and 10 extreme driving conditions based on driver experience level and trailer configuration. Overall, the majority of participants from all trailer types and experience levels provided ratings in the realistic range for each of the emergency maneuvers and extreme driving conditions. Also, million-miler ratings were compared to non-million-miler ratings using Kruskal-Wallis chi-square tests. Results indicated that million milers and non-million milers typically provided similar ratings to each emergency maneuver and extreme driving condition, regardless of whether the participant drove a van, doubles, or tanker trailer driver.

Additionally, participants received a categorical rating based on their driving response to each of the emergency maneuvers and extreme conditions. The ratings for all 48 drivers were assigned by the same experimenter and included “responded appropriately,” “responded inappropriately,” and “did not respond/collision.” Overall, the majority of participants from all trailer types and experience levels responded appropriately to the emergency maneuvers and extreme conditions.

Comparisons between the responses, based on ratings assigned by the experimenter, of

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million-miler and non-million-miler participants were evaluated. Fisher's exact statistical significance test was used to evaluate the emergency maneuvers and extreme conditions. The results indicated that both million milers and non-million milers typically had similar responses for most of the emergency maneuvers and extreme conditions. However, a significant difference was observed during the evasive maneuver scenario and the front tire blowout scenario. In both scenarios, the million milers were more likely to respond appropriately than non-million milers. Further, a significant difference was observed for the black ice scenario, with non-million milers more likely to respond appropriately. No other comparisons reached statistical significance.

Summary Findings and Recommendations

When participants' ratings for the emergency maneuvers and extreme conditions were evaluated, the majority of participants felt these showcase scenarios were realistic when compared to their real-world counterparts. These findings indicated that the simulator was able to produce a realistic simulation of many different types of emergency maneuvers and extreme conditions. Most drivers provided favorable ratings for the ability of the simulator to replicate potentially hazardous emergency situations and extreme conditions in a safe manner; thus, they believed the simulator could be used to successfully train drivers in defensive driving skills. No overall pattern of statistically significant differences between million milers and non-million milers were found in the ratings of the showcase scenarios' realism. This suggests that the realism in the simulated events encountered was not limited to a certain group of drivers based on the amount of driving experience.

The overall driver performance during the emergency maneuvers and extreme driving conditions demonstrates that a majority of the participants responded appropriately to each of the scenarios encountered. However, there were some interesting results present when each set of conditions was evaluated in detail. The results of this showcase demonstrated that million milers responded appropriately more often than non-million milers during the emergency maneuvers and extreme conditions; however, the million milers still responded inappropriately or not at all in approximately 30 percent of the emergency events and 32 percent of the extreme conditions encountered. These results indicate that all participants, including million milers, could potentially benefit from refresher and defensive driving training.

The simulator is one such mechanism for providing this type of training. Thus, the advanced capabilities scenarios described here could be used as part of a training program for such refresher and defensive driving training. Further, this demonstration of simulator capabilities could also enhance and provide the basis for improvements in future training of both novice and experienced drivers. Additionally, these participants' evaluations could lead to future improvements in simulation technology.

References

National Highway Traffic Safety Administration. (2008). Fatality Analysis Reporting System, 2008 data. Retrieved May 2010 from http://www-fars.nhtsa.dot.gov.