TechBrief

FEDERAL MOTOR CARRIER SAFETY ADMINISTRATION

Contact: Jerry Robin, MCS-30, (202) 366-2985

Validation of Simulation Technology in the Training, Testing, and Licensing of Tractor-Trailer Drivers

The goal of the Federal Motor Carrier Safety Administration (FMCSA) is to reduce the number and severity of large truck-involved crashes through more commercial motor vehicle and operator inspections and compliance reviews, stronger enforcement measures against violators, expedited completion of rulemaking proceedings, scientifically sound research, and effective CDL testing, recordkeeping, and sanctions. The Office of Research and Technology manages research and technology development and deployment programs for the FMCSA.

There are eight major research and technology focus areas: crash causation and profiling; regulatory evaluation and reform; compliance and enforcement; HAZMAT safety and cargo tank integrity; driver training and performance management; driver alertness and fatigue; driver physical qualifications; and car-truck proximity.

***Driver training and performance management* includes research on driver recruiting, selection, training, testing, licensing, and safety performance management.**

Office of Research and Technology
400 Seventh Street, SW
MCS-30; Room 3107
Washington, DC 20590

Introduction

Simulators have been successfully employed in the military and commercial sectors for several decades. While most simulation technology was developed to satisfy aviation training needs, similar technology has been applied to training in other contexts: nuclear power stations, petrochemical plants, ground vehicles, ships, and locomotives. Now, low-cost, full-mission, high-fidelity commercial motor vehicle (CMV) simulators are available, and may be useful to supplement the training, testing, and licensing of CMV drivers.

On the basis of a 1996 Federal Highway Administration (FHWA) report that evaluated the functional capabilities of truck driving simulators, the Federal Motor Carrier Safety Administration (FMCSA) is pursuing the validation of truck simulator technology. Although CMV simulator technology is available, there had been little previous effort by either the private or public sector to examine the transferability of simulation training to real driving, or to assess its usefulness, effectiveness, or efficiency. This tech brief summarizes the final report addressing the research design of the planned validation study.

Purpose

The FMCSA is seeking to empirically validate a low- to mid-cost simulator for purposes of CMV driver training, testing, and licensing. In the first phase, which is the focus of this tech brief, researchers developed a research design to validate the use of simulation technology. In the second phase, researchers will conduct the follow-on empirical study using the Phase 1 research design.

The Phase 1 research plan was designed to determine if the use of simulator-supplemented training, as compared to traditional behind-the-wheel (BTW) training, results in the same, better, or worse performance in driver training and on the commercial driver's license (CDL) examination. Provisions for a longitudinal study will also ascertain the relationship between type of training method (i.e., simulation vs. truck) and actual job performance by determining if simulator-based training ultimately results in reliable differences in a driver's on-the-road performance.

Methodology

Because the focus of this project was to develop a research design that adequately validated truck driving simulator technology, researchers sought to better understand the requirements of the training and licensing industry. A preliminary outline of the

initial, proposed research design and subsequent status update was presented several times to the Subcommittee on Simulation and Measurement of Vehicle and Operator Performance at the annual meetings of the Transportation Research Board. Suggestions from these sessions were incorporated into the final validation design. Researchers directed considerable effort toward developing driving scenarios that could provide the appropriate out-of-window forward scenes, coupled with the training requirements for novice truck drivers.

A workshop was held on April 16, 1996 that included experts from the trucking industry, simulation experts, truck driver training experts, regulatory groups, the research community, FMCSA, and other government agencies. The objective of the workshop was to obtain input from external reviewers to develop driving scenarios, both traditional and advanced. Scenarios for the advanced driving capabilities were fine-tuned and consolidated to capitalize on the capabilities of the technology at that time.

In addition to conducting the scenario review workshop, FMCSA conducted informal interviews with representatives from the U.S. Department of Transportation, other federal agencies, Transport Canada, motor carrier industry training organizations, simulator vendors, and potential users. In general, discussions with representatives from the motor carrier industry indicated that they favored the use of simulators for CMV driver training.

A preliminary draft of the research design was submitted to a peer review process in June 1997; members of the review panel included researchers, simulation experts, training experts, regulators, members of the heavy vehicle industry, and U.S. and international government representatives. This workshop resulted in a refinement of the original design, focusing on measures of performance, points for the longitudinal test, data collection, and study logistics.

Planned Research Design

The validation study design is divided into three parts. Part 1 incorporates a transfer of training paradigm, allowing for the comparison of training effectiveness. (Transfer of training is defined as the influence of past learning on present learning and job performance.) The CDL will be the criterion task for providing evidence that simulation-based training results in equivalent or better performance on the licensing examination. Part 2 is the assessment of the advanced driving capabilities using simulation and will demonstrate potential applications to enhance the licensing environment. Part 3 will be a longitudinal study to determine the effect of simulation-based training on job performance outcomes. A comprehensive analysis of the collected data will follow.

Part 1 — Transfer of Training

This portion of the study involves a forward transfer of training with student tractor-trailer drivers who will be trained on all units of the Professional Truck Driver Institute (PTDI) curriculum, as modified in the peer review for purposes of this study. Fifty-four novice truck drivers will be recruited and the participants will be required to possess a valid commercial driver learner's permit and to meet state medical, age, and drug and alcohol testing requirements.

Students will be divided into two groups, with one group receiving conventional truck-based training, and the other group receiving simulator-supplemented training. The control group will receive all BTW training (44 hours) in an actual vehicle, except for some limited exposure to the simulator for familiarity purposes; the experimental group will receive 66 percent of the BTW training in a simulator (30 hours) and the rest (14 hours) in a vehicle. Simulator assessment will take place on 10 of the 16 units of the PTDI curriculum (Basic Operation and Safe Operating Practices portions) as modified in the peer review:

Basic Operation

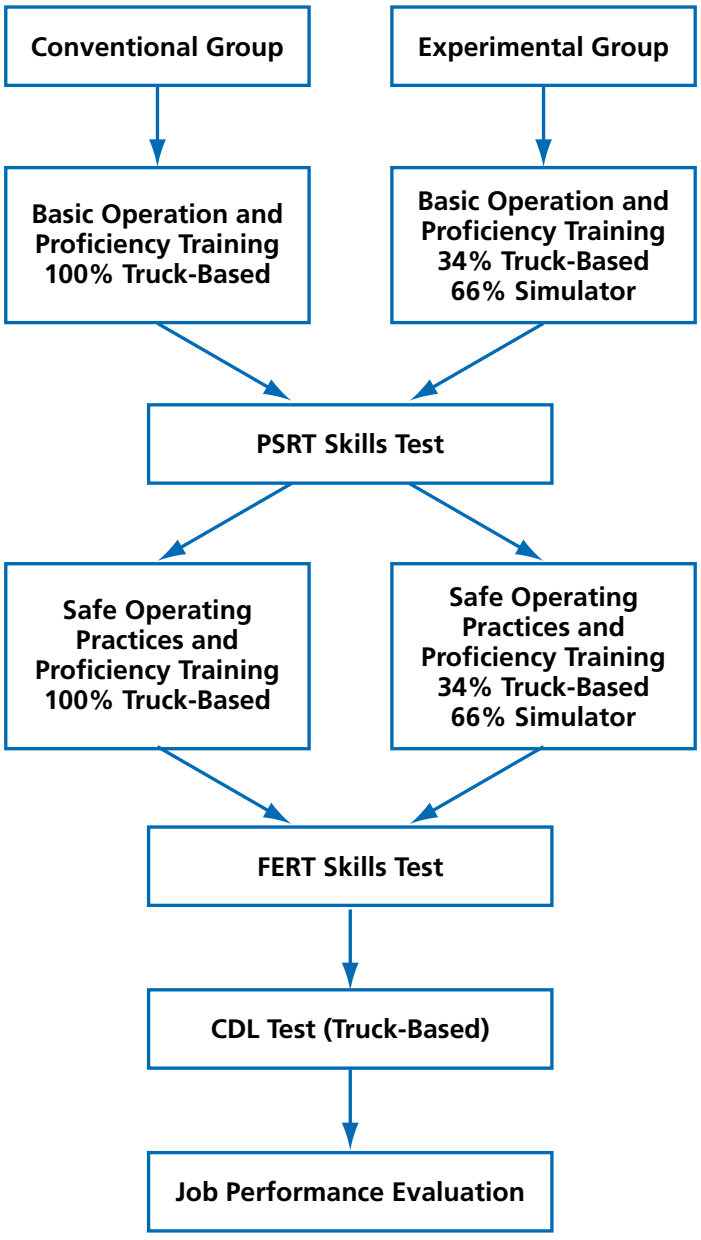
- Basic Control
- Shifting
- Backing
- Coupling and Uncoupling
- Proficiency Development

Safe Operating Practices

- Visual Search
- Communication
- Space Management
- Night Operation
- Proficiency Development

Driver performance will be assessed and measures will include the number of trials necessary to achieve the skill-level objectives for each of the training lesson units, and the amount of time necessary to pass the skill unit. In addition to the requirements for the instructional units, student drivers will perform two in-course skills tests, the Pre-Street Range Test (PSRT) and the Final

Figure 1.
Transfer of Training Research Study Design



PSRT = Pre-Street Range Test
FERT = Final Examination Road Test
CDL = Commercial Driver's License

Examination Road Test (FERT). Both of the in-course tests have traditionally been performed in a truck. Student drivers in both the control group and the experimental group will attempt the PSRT and the FERT first in a truck, then in the simulator. The ultimate criterion task for the transfer of training will be the student driver's performance on the CDL examination. **Figure 1** illustrates the proposed research study design for Part 1.

Part 2 — Advanced Capabilities

Part 2 of the research design provides for an evaluation of the advanced capabilities of the simulator to replicate the more complex driving skills, such as the operation of double and triple combination vehicles, evasive maneuvers, jackknives, and driving on black ice. Simulation appears to lend itself particularly well to driving situations that are dangerous, unusual, or infrequently encountered. The objective of the advanced capabilities assessment is to "showcase" and assess the technology to determine the efficacy of simulation for training, testing, and licensing CMV drivers on these particular maneuvers and vehicle configurations.

For this part of the study, researchers plan to recruit two groups of eight drivers, experienced and novice. Experienced drivers will have had at least 15 years of professional truck driving experience, a tenure of at least 2 years with the same carrier, and no recordable accidents or citations for 3 years. Novice truck drivers will be a subset of the students participating in Part 1 of the study who obtained their CDL.

After drivers receive a brief orientation to the simulator, researchers will administer a general skills pre-test to establish baseline differences between the two groups. Scores from the pre-test will be collected in the form of instructor's observation for the number of pass/fail performances on each trial. Following the pre-test, all drivers will be tested individually on four defined advanced capabilities scenarios: Special Rigs (triples and doubles), Speed Management, Extreme Driving Conditions, and Emergency Maneuvers. Upon completion of the scenarios, all drivers will participate in a post-test similar to the pre-test. Additionally, the experienced drivers will complete a post-experiment questionnaire to determine the degree of agreement among experienced truck drivers on the simulator's ability to present driving situations in a realistic and useful manner.

Researcher
This study was performed by Science Applications International Corporation in collaboration with George Mason University.

Distribution
This Tech Brief is being distributed according to a standard distribution. Direct distribution is being made to the Service Centers and Divisions.

Availability
The study final report is available from the National Technical Information Service, Telephone: (703) 605-6000.

Key Words
driving simulator, truck driver training, heavy trucks, commercial motor vehicles, tractor-trailers.

U.S. Department of Transportation
Federal Motor Carrier Safety Administration

February 2000
Publication No. FMCSA-MCRT-00-007

Part 3 — Longitudinal Study

This longitudinal study is a continuation of Part 1, and will determine if simulator-based training ultimately results in reliable differences in drivers' performance. The student drivers' post-training driving records will be examined at 3 and 12 months following the completion of the CDL examination. Measures of on-the-job driver performance during this part of the study will include the number of crashes, the number of citations, supervisory ratings, and other measures as deemed appropriate.

Continuing Research

Given technological advances and cost reductions since the first simulator market assessment in 1996, Phase 2 of this research project includes a market reassessment of the simulator technology to assure that the truck simulator to be used in the study reflects the most up-to-date technology. The market reassessment is currently being conducted and will recommend a simulator for use in the follow-on validation study. The reassessment is scheduled for completion by mid-2000. The actual simulator validation empirical study will begin in FY 2001.

Final Reports

The final report on which this tech brief is based, *Validation of Simulation Technology in the Training, Testing, and Licensing of Tractor-Trailer Drivers,* is available from the National Technical Information Service (NTIS), order number: PB2000-100587 The final report can also be accessed at the USDOT Information Services Web site: **http://isweb.tasc.dot.gov**, report number: FHWA-MC-99-060.

The 1996 FHWA report to validate the functional capabilities of truck driving simulators, *Commercial Motor Vehicle Simulation to Improve Driver Training, Testing, and Licensing Methods*, is also available from the National Technical Information Service (NTIS), order number: PB96-183405.