Commercial Motor Vehicle Driving Simulator Validation Study: Phase II

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Project Background

- NTSB recommendation to encourage development/use of simulator-based training for heavy truck operators
- Findings from prior research studies:
  - Dueker (1995)
  - Knipling, Hickman, & Bergoffen, (2003)
  - Stock (2001) and Dugan (2008)
- Commercial availability of high-fidelity, “full mission” truck driving simulators at steadily decreasing prices.
- Simulators successfully implemented as part of CMV driver training programs in Europe

Research Objectives

1. Examine the effectiveness of a driving simulator for entry-level commercial motor vehicle (CMV) driver training and testing.
2. Determine how different entry-level training methods compare in terms of skills acquisition and transfer of training.
3. Investigate the relationship between type of training method and actual job performance.
4. Evaluate the advanced capabilities of the simulator for testing emergency maneuvers and extreme conditions utilizing various vehicle configurations.

Project Setting

- Commercial Transportation Program at Delaware Technical and Community College (DTCC), Georgetown DE
- Virginia Tech Transportation Institute (VTTI) researchers
- FAAC Model TT-2000-V7 3 DOF Simulator.
- Project Period: Aug 2006 – Mar 2010

FAAC, Inc., Model TT-2000-V7 Driving Simulator

Exterior view

Interior view

FAAC, Inc., Model TT-2000-V7 Driving Simulator

Research Design

- Compare the research results of four different types of training methods:
  - Long certified conventional behind-the-wheel (BTW) training, termed *long conventional group* (104hrs/44hrs).
  - Long certified simulator-based training (2/3 with simulator,1/3 BTW), termed *simulator group*.
  - Informal training (e.g., drivers trained by friends or family members), termed *no formal training group*.
  - Short, CDL-focused truck driver training school, termed *CDL-focused group*.
- Longitudinal Follow-up
- Advanced Capability Study (ACS)

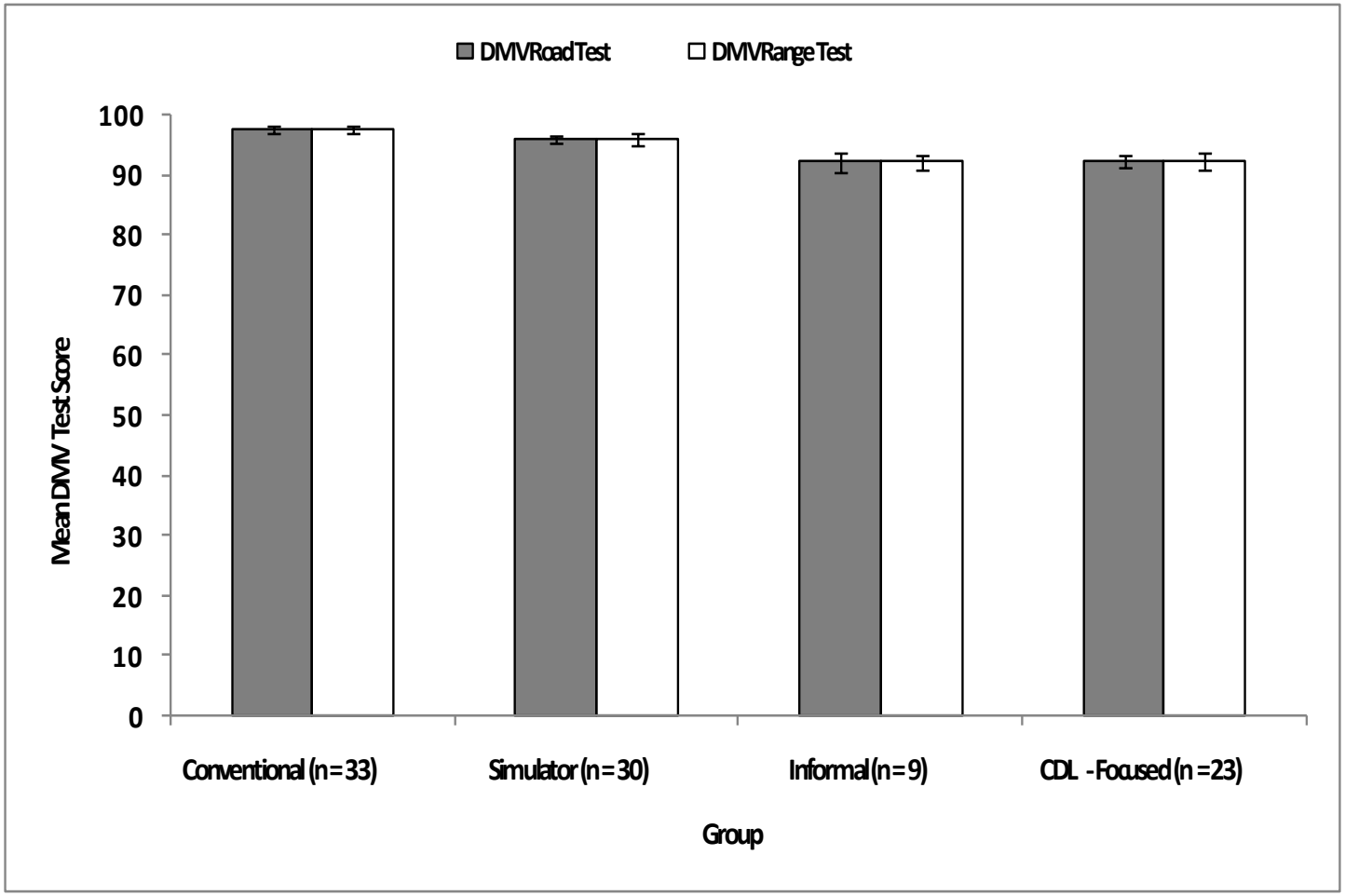
Performance Metrics

- Department of Motor Vehicle (DMV)
  - Knowledge, Road and Range Test Scores
- Delaware Technical and Community College (DTCC)
  - Road and Range Test Scores
- Simulator
  - Road and Range Test Scores
- Longitudinal Follow-up
  - 4 to 5 month driver assessment
  - 12-month CDLIS driving records

Participants

Training Group	Number of participants	Mean Age	Gender
Conventional	33	34	31 male, 2 female
Simulator	32	35	31 male, 1 female
Informal	9	40	9 male, 0 female
CDL-focused	33	35	30 male, 3 female

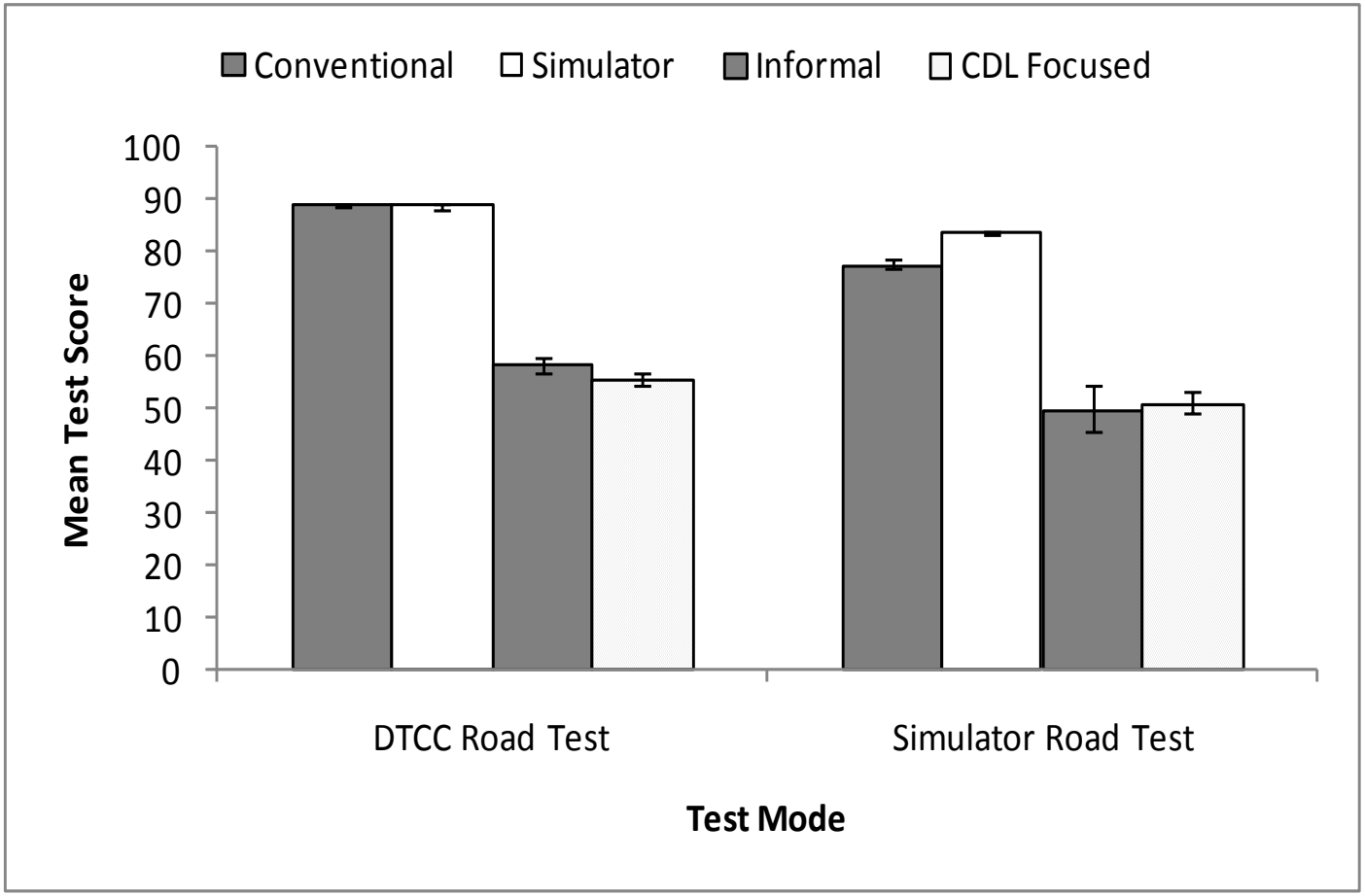
Does the training method affect DMV road/range test performance?



DMV Test Findings

- The mean DMV road and range test scores were above 90 percent, regardless of group membership
- The ANOVA for the DMV road test found no significant group differences between groups $F(3, 91) = 1.94$, $p = 0.13$.
- The ANOVA for the adjusted DMV range test found a significant effect for group, $F(3, 94) = 6.44$, $p = .0005$.
  - The conventional training group (97.6 percent) scored significantly higher than the CDL-focused (88.4 percent) and informal training group (86.6 percent)
  - There was no difference indicated between the conventional and simulator (93.6 percent) training groups

Results from DTCC & Simulator Road Tests



DTCC & Simulator Road Test Findings

- Significant group differences in DTCC road test scores $F(2, 78) = 109.39$, $p < 0.0001$
- Significant group differences in simulator road test scores, $F(2, 78) = 41.31$, $p < 0.0001$
- Conventional and simulator training groups had significantly greater scores on the DTCC road test
- Conventional and simulator training groups scored significantly higher on the Simulator road test

Comparison of Simulator and BTW Testing

- Final scores on BTW and simulator road and range tests were compared
- BTW road test scores were significantly greater than the simulator road test scores
- BTW range test scores were greater than the equivalent simulator range test scores
- Simulator-based testing for CMV drivers does not appear feasible with current levels of simulator technology

Findings: Research Objective 1

- BTW and Simulator trained participants do not differ significantly in test performance
- Use of simulators in entry level training appears feasible
- Students trained in a PTDI-certified program, on average, scored better than the drivers that did not undergo a certified training program in most of these tests
- Simulator-based testing for CMV drivers not feasible with current simulator technology

Longitudinal Effects of Training Method on Driver Performance

- Does training method affect performance on retests 4–5 months after they start working as a commercial driver where a CDL is required?
- How does different entry-level training methods compare in terms of skills acquisition and transfer of training?
- Does training method affect safety performance on the job (e.g., incident rates, number of violations, number of crashes, supervisor ratings) after 4 and 12 months on the job?

Status of Participants for Follow-up Testing

Training Group	Participants Completed Initial Testing	Participants Eligible for Follow-Up	Participants Screened for Follow-Up	Participants Completed 4-Month Testing
Conventional	33	10	7	4
Simulator	32	15	15	13
Informal	9	8	3	2
CDL-focused	33	10	3	3

Findings: Research Objectives 2 & 3

- Most of the follow-up test scores were lower than the original scores during the entry-level tests.
- The conventional and simulator groups performed better on the follow-up road tests than the Informal and CDL-focused groups
- No computation for statistical significance due to limited sample size
- There was limited data to determine differences in safety records between groups.

Assessing Advanced Capabilities of the Simulator

- Are there differences in driver performance between million mile drivers and non-million mile drivers ?
  - Emergency maneuvers with different vehicle configurations
  - Driving under hazardous or extreme road conditions corresponding to their vehicle configuration experience.

Advanced Capabilities Study Participant Demographics

Driver Type	*Number of Participants*	Million Miler Status	Mean Age	Gender	Mean Years Experience	Mean Miles Logged
Van Trailer	6	Million Miler	51	6 male, 0 female	31.3	2,942,976
Van Trailer	10	Non-Million Miler	44	9 male, 1 female	7.7	439,100
Doubles Trailer	6	Million Miler	51	6 male, 0 female	23.0	2,281,976
Doubles Trailer	10	Non-Million Miler	42	10 male, 0 female	12.0	537,687
Tanker Trailer	6	Million Miler	51	6 male, 0 female	29.5	2,538,667
Tanker Trailer	10	Non-Million Miler	42	10 male, 0 female	10.1	402,300

Simulator's Advanced Capabilities

Emergency Maneuvers	Extreme conditions
Merge Squeeze	Fog
Lane Cross	Rain
Tire Blowout	Snow
Rollovers—Right	Black Ice
Rollovers—Left	8% Upgrade
Brake Failure	8% Downgrade (Dry)
Evasive Maneuver	8% Downgrade (Snow)
Animal Crossing	Dirt Road
Blind Entrance	Construction Zone
Pedestrian	Railroad Crossing
Tight City Turns	Fog
Roadway Obstruction	Rain

Findings: Research Objective 4

- Findings indicate that the simulator was able to produce a realistic simulation of many different types of emergency maneuvers and extreme conditions.
- Overall, million milers responded appropriately to the 12 emergency maneuvers and 9 extreme conditions more often than non-million milers.
- 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.
- Results indicate that all participants could potentially benefit from refresher and defensive driving training using simulators.

Summary of Findings

- Use of simulators in entry level driver training appears feasible
- Simulator-based testing for CMV drivers does not appear feasible with current levels of simulator technology
- There were differences between groups on DTCC and Simulator versions of DMV tests, suggesting that more training leads to greater performance on these tests.

Summary of Findings

- No differences in safety records were able to be determined from longitudinal follow-up.
- ACS participants generally rated the scenarios as realistic.
- Million milers responded to simulated events appropriately more often than non-million milers.

Implications for Future Research

- Prospective vs. Retrospective study
- Initial training vs. Experience
  - Post training confounding factors
- Is crash reduction the appropriate surrogate for measuring the safety benefits of training?

Questions?

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